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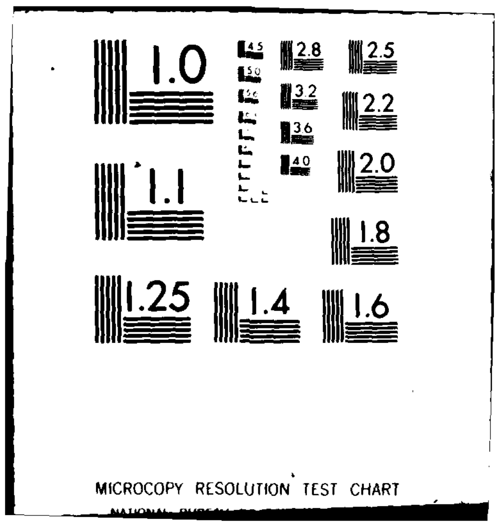
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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

MANNING THE NUCLEAR SUBMARINE FORCE OF
THE 1980'S AND BEYOND: AN OFFICER STUDY

by

Gordon R. Dickens

June 1982

Advisor: R.S. Elster

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in an attempt to identify an optimum accession and/or lateral entry program. Finally, the Navy's ability to meet the required accession goals is assessed by studying the projected supply of college graduates qualified to enter the nuclear submarine force.

The pattern of shortages and surpluses projected indicates that unless attrition rates can be reduced, it will not be possible to fully man the submarine force with nuclear qualified officers before 1993 without a policy of lateral entry, for example, nuclear engineers working in industry. In the long run, all shortages can be eliminated by a policy of increased accessions.

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Manning the Nuclear Submarine Force of
the 1980's and Beyond: An Officer Study

by

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Submitted in partial fulfillment of the
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I. INTRODUCTION

On March 4, 1981, the Secretary of Defense, the Honorable Casper W. Weinberger, presented a defense plan to Congress that sought an increase in strength across almost the entire spectrum of American military power. An important segment of that plan was a program aimed at rapidly expanding the Navy from 455 ships to 600 in order to restore "unquestioned American naval supremacy" [Ref. 1: p. 24].

On October 7, 1981, speaking before the Dallas Council of the Navy League of the United States, the Secretary said:

> The requirements of maritime power as dictated by our need to maintain vital access to NATO, to Southwest Asia and to our Pacific allies, require at minimum a 600 ship Navy based on 15 carrier battle groups. [Ref. 2: p. 41]

With that statement the Secretary was simply reiterating what has been the policy of President Reagan's administration ever since the March 4 presentation to Congress; and today that commitment appears to be as firm as ever.

Although the final composition of this 600 ship Navy is still not clear, an increase in the size of the nuclear submarine force is planned. The current five year ship building plan includes the construction of 17 new nuclear attack submarines (SSN) by 1987, and the continued construction of 1 Trident submarine (SSBN) each year for a total of 9 [Ref. 3: p. 7].

Unfortunately, in the past there has been a chronic shortage of nuclear qualified submarine officers to man even the existing fleet. On March 31, 1976, Admiral Hyman G. Rickover, USN, then Director of the Division of Naval Reactors, Energy Research and Development Administration, and Deputy Commander for Nuclear Propulsion, Naval Sea Systems Command, testified before the Department of Defense Subcommittee of the House of Representatives Committee on Appropriations that the inventory of nuclear qualified officers was only 71% of the requirement [Ref. 4: p. 17]. Shortages in the number of nuclear qualified officers, particularly submarine, continue today and any increase in the size of the submarine force can only exacerbate the problem. When the importance of the nuclear submarine force to the strategic deterrent of the United States is considered, solving the manpower problem becomes critical to the success of the President's overall defense policy.

A. PURPOSE

The purpose of this thesis is threefold:

1. to examine the demand for, and supply of, nuclear qualified submarine officers in the ranks Lieutenant, Junior Grade (LTJG) to Commander (CDR) during the 1980's and beyond,
2. to examine the relative effectiveness of alternative accession policies aimed at redressing any shortfalls revealed, and

3. to assess the Navy's ability to meet these required accession levels during the 1980's.

Ensigns have been excluded from the analysis because of the lack of suitably disaggregated data. At the time of the analysis the author was not able to separate nuclear qualified Ensigns from those not qualified. Accordingly "accessions" should be interpreted as flows into the rank of LTJG. No analysis has been conducted on ranks above CDR since, with the exception of two Captains for each SSBN, 726 (Trident), all sea billets are filled by a CDR or below.

B. ASSUMPTIONS

Throughout the analysis, a number of assumptions have been maintained:

1. A nuclear qualified officer is defined as an officer who is a graduate of Nuclear Power School.
2. The Navy will expand to 15 battle groups and approximately 600 ships by 1990.
3. All new submarines will be nuclear powered.
4. The same types of boats requiring the same officer manning as those currently in the fleet will be built during the 1980's.

In addition to these general assumptions, a number of specific assumptions have been made at various points throughout the analysis and these will be highlighted in the sections to which they refer.

C. METHODOLOGY

The methodology employed follows six basic steps. In Chapter II, the expected number of sea billets to be filled each year is estimated by multiplying the manning requirement for each class of submarine, as promulgated in the current ship manning document (SMD) [Refs. 5-11], by the number of that class of boat expected to be in the fleet in that year. The summation of all classes then gives the total demand for sea billets for each year under consideration. To emphasize that this requirement for sea billets represents the number of officers required to man the submarines of the fleet, it has been entitled, "boat manning demand."

Having established the sea-billet requirement, the number of shore billets necessary to permit a specified sea/shore rotation for each rank is estimated by multiplying the number of sea billets by the required rotation ratio. Once again, to emphasize that this shore-billet requirement represents the number of officers not on sea duty at any particular time who must be available to allow a specified rotation ratio, it has been entitled, "rotation demand." The summation of these two requirements is the total number of officers (billets) necessary to man the fleet and provide the specified rotation ratio for each year considered.

It should be noted that the number of shore billets is completely dependent on the number of sea billets required, and the specified rotation ratio. No attempt has been made to estimate the number of shore billets actually necessary in

the nuclear-submarine force. The number of officers required for rotation purposes, i.e., rotation demand, may be greater than, less than, or equal to, the number actually required to fill necessary positions ashore.

As will be discussed in detail in Chapter II, four possible total demand scenarios are then developed by making different assumptions on which positions are filled by nuclear-qualified officers and the desired rotation ratio. The same projected fleet inventory is used throughout the analysis.

In Chapter III, a computer model known as MANMOD, which is available at the Naval Postgraduate School, is used to project the number of nuclear-qualified officers expected to be available during the 1980's and beyond. Starting with the current stock of nuclear qualified officers, three different attrition-rate vectors and two promotion-rate vectors are utilized to generate six possible supply scenarios. In Chapter III, accessions into the rank of LTJG are kept constant at 400 per annum, the average number achieved over the past 3 years. In Chapter V the effect of different accession rates is explored.

In Chapter IV the projected annual supply of officers of each rank is simply subtracted from the corresponding demand projection and the resulting surpluses, or shortages, are presented in matrix form. The areas of deficiency are examined in some detail for the period 1982-1990. The author's concern here is with the immediate problem of manning

the increased number of boats through the decade of the '80's. In Chapter V the period 1982 through 1997 is examined with a view to establishing an optimum accession policy for the long term.

Finally, in Chapter VI, an attempt is made to assess how difficult it is going to be for the nuclear submarine force to recruit suitably qualified young men in the numbers indicated by the analysis of Chapter V. Unfortunately, no detailed studies have been conducted on what factors significantly affect the level of officer accessions, as has been the case with enlisted recruitment. It was not possible, therefore, to conduct any type of regression analysis in order to predict the supply of officer accessions. This study has thus been restricted to a somewhat subjective assessment of the future recruiting environment. During the 1980's, is it going to be easier, or harder, to meet accession goals than it has been in the past? Firstly, the sources of supply of potential officers and the qualifications required are described and the historical record of the Navy's officer accession program is examined. Trends in the nuclear submarine force's requirement for accessions are then compared with projected trends in the supply of suitably qualified college graduates and the level of civilian demand for those same graduates.

II. DEMAND

In this chapter, four demand scenarios are developed on the basis of a projected fleet mix, two assumed manning requirements for nuclear-qualified officers and two assumed sea/shore rotation ratios. The development of each scenario is illustrated in Fig. 1.

A. PROJECTED FLEET MIX

Because it forms the start point for all subsequent calculations, the assumed composition of the fleet, both as it grows through the decade and in its final form as part of a 600 ship Navy, is central to any conclusion that may be drawn from the following analysis. Unfortunately, this mix is also difficult to predict because it is subject to political decision, and it is subject to the uncertainty of construction times, technological developments, and changes in the perceived threat.

Nevertheless, some assumed fleet mix is essential, and the mix that has been chosen to form the basis for the analysis that follows is the projection developed in the Naval Postgraduate School 600 Ship Study conducted during the first one-half of 1981 (Table 1). This projection was developed by naval officers studying at NPS in 1981 after close consultation with sources in Washington, D.C. The projection conforms closely with statements made by the Secretary of Defense.

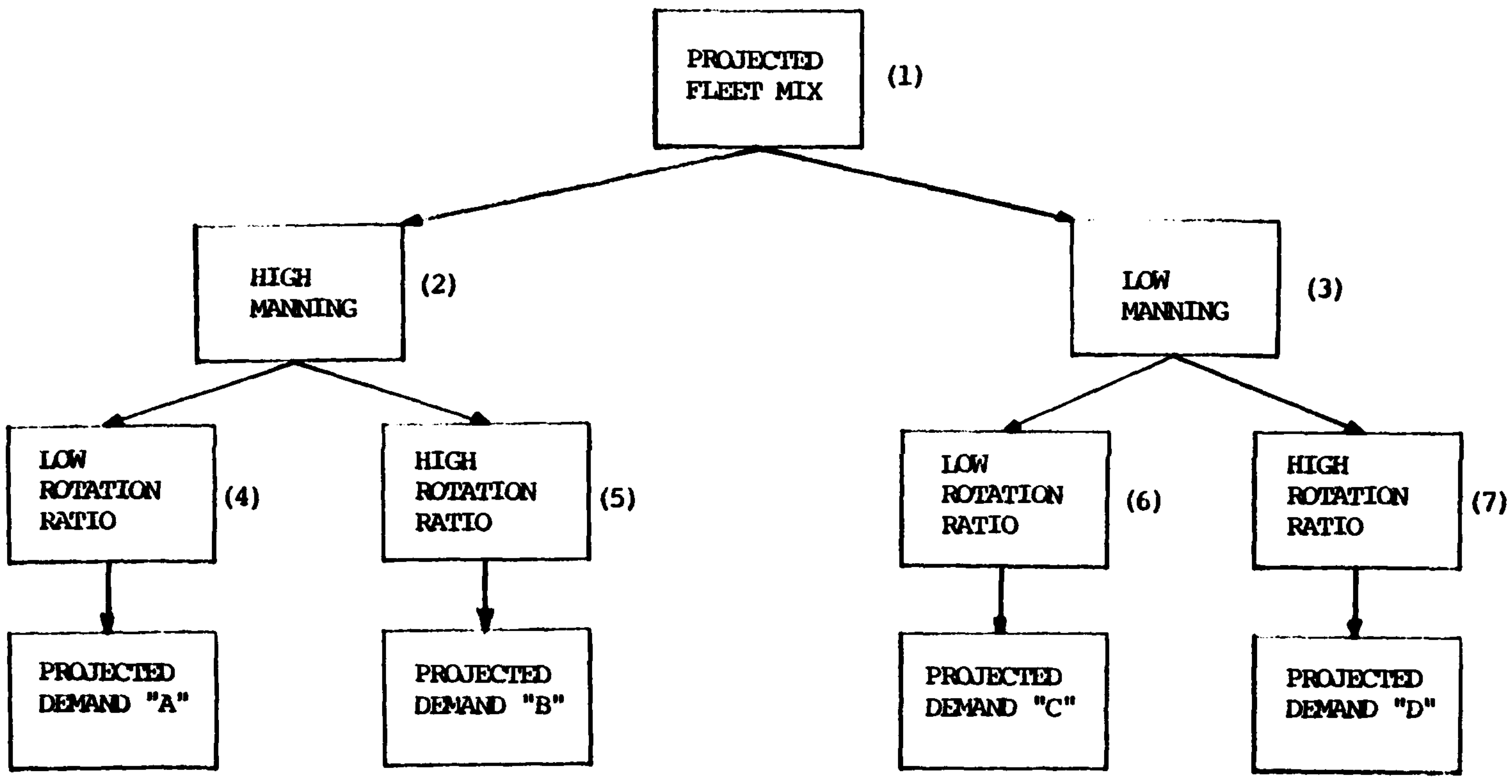

Figure 1. DEMAND MODEL: NUCLEAR QUALIFIED SUBMARINE OFFICERS

TABLE 1

PROJECTED FLEET MIX: 1982-1990

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
TYPE									
SSN 575	1	1	--	--	--	--	--	--	--
SSN 597	1	1	1	1	1	1	1	1	1
SSN 585	5	5	5	5	5	5	5	5	5
SSN 594	13	13	13	13	13	13	13	13	13
SSN 637	37	37	37	37	37	37	37	37	37
SSN 671	1	1	1	1	1	1	1	1	1
SSN 688	16	19	24	28	31	34	37	40	40
SSN 578	4	4	3	2	1	--	--	--	--
SSN 598	3	3	3	2		--	--	--	--
SSN 608	5	5	5	5	5	5	5	5	5
SSN 685	1	1	1	1	1	1	1	1	1
SSBN 726	1	2	3	4	4	5	6	7	8
SSBN 616/627/640	31	31	31	31	31	31	31	31	31

SOURCE: NPS 600 Ship Study, June 1981

The current ship building plan revealed by the Administration in September 1981 proposes to build 17 new nuclear-attack submarines by 1987, for a total of 33 against a predicted, in March 1981, total of 34, plus continued production of 1 SSBN Trident submarine per year [Ref. 3: p. 7]. This last proposal is also reflected in Table 1. Over the same period it is anticipated that a number of the older types of submarines, notably SSN 575, 578 and 598, will be decommissioned as their reactor lives expire.

B. FOUR DEMAND SCENARIOS

1. Boat Manning Demand

To develop two levels of boat manning demand, it was first assumed that all positions were to be filled by nuclear qualified officers. This is not presently the case, but the author has been led to believe that this is the ultimate goal; so the assumption has been included to establish an upper bound on the number of sea billets that must be filled by nuclear-qualified officers. This level of demand is represented by box (2) in Fig. 1 and is called "High Manning."

To establish a lower bound on manning demand, it was assumed that selected positions need not be filled by nuclear-qualified officers. This level of demand is represented by box (3) in Fig. 1 and is called "Low Manning."

The officer manning requirements of each class of submarine represented in the fleet, as promulgated in the applicable SMD, are given in Table 2. Each SSBN has two

TABLE 2

MANNING REQUIREMENTS: NUCLEAR QUALIFIED OFFICERS
"HIGH MANNING"

SHIP TYPE / RANK	SSN 575 597 585	SSN 671 688,637 594	SSN 578 598,608 685	SSBN*# 726	SSBN# 616 627 640
CDR	1	1	1	2	2
LCDR	2	2	3	6	6
LT	3	3	2	8	4
LTJG	3	4	4	6	8

*Does not include 2 x Captain for each boat.

#SMD requirements have been doubled to include both Blue and Gold crews.

crews known as the BLUE crew and the GOLD crew. Cruises are of three months duration with each crew alternating three months at sea, three months ashore. However, for the purposes of this study both crews are considered to be performing sea duty, and the manning requirement for this type of submarine, as given in the SMD's, has been doubled in Table 2. As discussed previously two Captains for each Trident, and Ensigns are excluded from the analysis. Also excluded are supply officers, designator 3100. Classes with identical manpower requirements have been grouped for ease of computation. During computational work, the projected fleet mix was similarly grouped, but it has been presented by individual class so as to show more clearly the expected changes in the fleet mix over time. Table 2 reflects the assumption that all positions are to be filled by nuclear qualified officers and therefore represents "high manning."

The positions assumed not to require a nuclear-qualified incumbent are listed in Table 3. It is stressed that these positions do not reflect any official policy. They have been selected by the author on the basis of various conversations with nuclear-qualified submarine officers at the Naval Postgraduate School and in Washington, D.C. After these positions are deleted, the manning requirement for nuclear-qualified officers is as listed in Table 4. Table 4 therefore represents "low manning."

Applying each manning level to the projected fleet mix results in two levels of "boat manning demand," which

TABLE 3

MANNING REQUIREMENTS: "LOW" POSITIONS DELETED

POSITION TITLE	RANK
SHIP NAV GEN	LCDR
SHIP NAV (INSTR)	LCDR
OPS AFLOAT GEN	LT
WEAPONS GEN	LT
WEAPONS FBM	LT
DIV WEAPONS GEN/ TACTICAL SYSTEMS OFR.	LT
COMM AF	LT
DIV WEAPONS GEN/SO	LTJG
WEAPONS FBM/AS	LTJG

TABLE 4

MANNING REQUIREMENTS: NUCLEAR QUALIFIED OFFICERS
"LOW MANNING"

SHIP TYPE RANK	SSN 575 597 585	SSN 671 688,637 594	SSN 578 598,608 685	SSBN*# 726	SSBN# 616 627 640
CDR	1	1	1	2	2
LCDR	2	2	2	2	4
LT	1	1	1	4	2
LTJG	2	2	2	4	4

*Does not include 2 x Captain for each boat.

#SMD requirements have been doubled to include both Blue and Gold crews.

represent the number of nuclear-qualified officers required to man the submarines of the fleet for each year under consideration under each manning assumption. Table 5 is the expected demand for nuclear-qualified officers if all positions are filled by qualified officers while Table 6 is the expected demand for nuclear-qualified officers if it is assumed that selected positions only need be filled by qualified officers.

2. Rotation Demand

To calculate the various levels of rotation demand, two separate sea/shore ratios have been defined; both are shown in Table 7. The first, called "low ratio" applies a 1 for 1 ratio between shore and sea duty time for all officers, except LTJG's, who spend all of their service in that rank on sea duty. This ratio has been extracted from a study by Teply in which he analyzed the sea tour opportunities of submarine officers [Ref. 12]. In his study, Teply used the number of years of service normally necessary to obtain a sea-tour position to form a matrix of normal sea-tour positions. For the purposes of this study, the same years of service have been utilized and substituted as a proxy for rank. This assumption is considered reasonable, because within the submarine community the rank required for a tour is commensurate with the normal advancement of officers who are promoted from within a relatively narrow promotion zone based on years of service.

TABLE 5

MANNING REQUIREMENTS: "HIGH"

1982-1990

YEAR RANK	1982	1983	1984	1985	1986	1987	1988	1989	1990
CDR	151	156	161	165	165	169	174	179	181
LCDR	379	391	402	410	407	416	428	440	446
LT	380	397	415	431	434	449	466	483	491
LTJG	595	613	632	646	646	660	678	696	702
TOTAL	1505	1557	1610	1652	1652	1694	1746	1798	1820

Increase ~ 21%

TABLE 6

MANNING REQUIREMENTS: "LOW"

1982-1990

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
RANK									
CDR	151	156	161	165	165	169	174	179	181
LCDR	300	308	316	322	322	328	336	344	346
LT	153	160	167	173	173	179	186	193	197
LTJG	302	312	322	330	330	338	348	358	362
TOTAL	906	936	966	990	990	1014	1044	1074	1086

TABLE 7

SEA/SHORE ROTATION RATIOS (YEARS)

RANK	LOW RATIO (1) SEA	SHORE	HIGH RATIO (2) SEA	SHORE
CDR	3	3	4	3
LCDR	3	3	3	2
LT	2-1/2	2-1/2	3	2
LTJG	2	0	2	0

(1) Teply, J.F., (1980)

(2) URL Career Guidebook, (1979)

The second ratio, called "high ratio" has been derived from the general tour-length policy as promulgated in the Commanding Officer's Addendum to the URL Career Guidebook published by the Military Personnel and Training Division in March, 1979 [Ref. 13]. Because the high ratio results in officers spending a greater proportion of their time on sea duty, it results in a smaller additional requirement for officers than does the low ratio.

Although neither ratio conforms exactly with the sea-tour lengths actually being achieved, they are considered to be close enough to form two quite reasonable options when considering what sea/shore rotation ratio is both desirable and achievable. For example, in the November/December 1981 issue of Perspective, a newsletter for Navy officers, it was reported that actual sea-tour lengths achieved by submarine officers relieved during 1981 were 3.8 years for Commanding Officers, i.e., CDR's, and 3.1 years for Executive Officers, i.e., LCDR's. Department Head tours, which are filled by both LT's and LCDR's, averaged 3.1 years also [Ref. 14].

Applying each of the two rotation ratios to each of the two levels of boat manning demand results in four levels of what has been termed "rotation demand," which represents the number of nuclear-qualified officers that must be filling shore-duty positions each year to allow the desired sea/shore rotation times for all officers. Table 8 is thus the number of officers required to meet rotation demands when the low rotation ratio is applied to the boat manning demand generated

TABLE 8

ROTATION DEMAND 1982-1990

"HIGH MANNING - LOW RATIO"

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
RANK									
CDR	151	156	161	165	165	169	174	179	181
LCDR	379	391	402	410	407	416	428	440	446
LT	380	397	415	431	434	449	466	483	491
LTJG	---	---	---	---	---	---	---	---	---
TOTAL	910	944	978	1006	1006	1034	1068	1102	1118

Increase ~ 23%

by the high manning assumption. This is the highest of the four levels of rotation demand and is represented by box (4) in Fig. 1. Similarly, Table 9 represents the combination of the high rotation ratio with the high boat manning demand. Since the higher rotation ratio requires that a smaller number of officers be available for rotation purposes, it is smaller than the first combination and is represented by box (5) in Fig. 1. Continuing, Table 10 represents the combination of the low rotation ratio with the low boat manning demand and is represented by box (6) in Fig. 1. Finally, Table 11 gives the lowest level of rotation demand, i.e., the combination of the high rotation ratio with the low boat manning demand, and is represented by box (7) in Fig. 1.

3. <u>Total Projected Demand</u>

Adding each of the above rotation demand levels to its corresponding boat manning demand, results in four projected levels of total demand. With reference, once again, to Fig. 1, total demand A represents the sum of boat manning demand under the high manning assumption and rotation demand under the high manning/low ratio assumption. This is the highest level of demand developed in the analysis. Similarly, total demand B is the sum of the high boat manning demand and rotation demand under the high manning/high ratio assumption. Total demand C is the sum of the low boat manning demand and rotation demand under the low manning/low ratio assumption. Total demand D, the lowest level, is the sum of the low boat

TABLE 9

ROTATION DEMAND 1982-1990
"HIGH MANNING - HIGH RATIO"

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
RANK									
CDR (4:3)	113	117	121	124	124	127	130	134	136
LCDR (3:2)	253	261	268	273	271	277	285	293	297
LT (3:2)	253	265	277	287	289	299	311	322	327
LTJG (1:0)	---	---	---	---	---	---	---	---	---
TOTAL	619	643	666	684	684	703	726	749	760

Increase ~ 23%

TABLE 10

ROTATION DEMAND 1982-1990

"LOW MANNING - LOW RATIO"

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
RANK									
CDR (1:1)	151	156	161	165	165	169	174	179	181
LCDR (1:1)	300	308	316	322	322	328	336	344	346
LT (1:1)	153	160	167	173	173	179	186	193	197
LTJG (1:0)	---	---	---	---	---	---	---	---	---
TOTAL	604	624	644	660	660	676	696	716	724

Increase ≈ 20%

TABLE 11

ROTATION DEMAND 1982-1990

"LOW MANNING - HIGH RATIO"

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
RANK									
CDR (4:3)	113	117	121	124	124	127	130	134	136
LCDR (3:2)	200	205	211	215	215	219	224	229	231
LT (3:2)	102	107	111	115	115	119	124	129	131
LTJG (1:0)	---	---	---	---	---	---	---	---	---
TOTAL	415	429	443	454	454	465	478	492	498

Increase ~ 20%

manning demand and rotation demand under the low manning/ high ratio assumption.

All four levels of total demand are summarized in Table 12. Over the period 1981-1990, the increase in the total officer requirement ranges from approximately 22% under demand A assumptions, to approximately 20%, under demand D assumptions.

TABLE 12

PROJECTED DEMAND
(TOTAL)

RANK	DEMAND PROTECTION	1982	1984	1986	1988	1990
CDR	A	302	322	330	348	362
	B	264	282	289	304	317
	C	302	322	330	348	362
	D	264	282	289	304	317
LCDR	A	758	804	814	856	892
	B	632	670	678	713	743
	C	600	632	644	672	692
	D	500	527	537	560	577
LT	A	760	830	868	932	982
	B	633	692	723	777	818
	C	306	334	346	372	394
	D	255	278	288	310	328
LTJG	A	595	632	646	678	702
	B	595	632	646	678	702
	C	302	322	330	348	362
	D	302	322	330	348	362

III. SUPPLY

Following the establishment of a number of demand scenarios, the next step is to develop some supply scenarios to match against these projected demand levels. To accomplish this, a computer model known as MANMOD, which is available at the Naval Postgraduate School, was used. Several supply projections were developed by varying the inputs into the model. To develop a single projection, four data inputs are required: the initial stock of officers, planned accessions, and any two of either the historical attrition rates, continuation rates, or promotion rates. Each of these rates is expressed as a fraction between zero and one inclusive, and all three must sum to one. Consequently, if two are know, the third may be calculated. In practice, the model uses only the continuation and promotion rates.

The projections in this study are based on a time increment of one year, although the results have been presented in increments of two years to avoid implying a higher level of precision than is in fact the case. Seasonal, quarterly, and monthly inventory fluctuations are ignored by applying promotion and continuation rates only once each period. The implicit assumption here is that attrition and promotion occur at a uniform rate through the year. Annual accessions are applied once at the end of each year. When an officer is promoted, his year group is not affected. For example,

a LT with 9 years of commissioned service (YCS) who is promoted during the period appears in the inventory for the next period as a LCDR with 10 YCS. If he is not promoted he appears as LT with 10 YCS.

This brief explanation and some further assumptions that must be appreciated to properly interpret the projections will suffice here. It is not intended to discuss the technical details of the model any further. The interested reader is referred to an excellent text by Bartholomew and Forbes entitled "Statistical Techniques for Manpower Planning" [Ref. 15]. All of the data necessary to construct the transition matrices used for the projections in this chapter are summarized in Appendix A. An explanation of the derivation of each input is given in the following sections.

A. DATA REQUIREMENTS

1. Initial Stocks

Firstly, the initial stock of officers, by rank and by YCS, must be known. In the analysis that follows, the initial stock of officers is defined as those nuclear qualified officers in the ranks LTJG to CDR who were available for duty as at Jan 30, 1982 (Table 13).

2. Promotion Rates

The promotion rate is defined as the percentage of the total number of officers of a particular rank and YCS cohort who are promoted during a given year. The promotion rates applied in this analysis are the rates currently being

TABLE 13

INITIAL STOCKS
NUCLEAR QUALIFIED SUBMARINE OFFICERS
AS OF JAN 30, 1982

	RANK			
YCS	LTJG	LT	LCDR	CDR
3	411			
4	328			
5		300		
6		197		
7		147		
8		100		
9		81	18	
10		2	72	
11			78	
12			54	
13			56	
14			64	
15			26	24
16			3	51
17			2	40
18			2	46
19				54
20				56
21				44
22				6
23				6
24				1
TOTAL	739	827	375	328

SOURCE: Submarine and Nuclear Officer Program Manager, OP NAV 132, Office of the Chief of Naval Operations.

used for planning purposes by OP132. Throughout the analysis, these rates will be referred to as "Promotion Rate-Plan."

The promotion plan specifies the promotion percentage for each cohort by rank and by YCS (Table 14). Promotion is only to the next highest rank, and occurs after four YCS for LTJG's, between eight and ten YCS for LT's, between 14 and 16 YCS for LCDR's and between 21 and 22 YCS for CDR's.

TABLE 14

Promotion Plan

Nuclear Qualified Submarine Officers

Rank to which Promoted	PROMOTION PERCENTAGE					
	Below Zone		Zone		Above Zone	
	YCS	%	YCS	%	YCS	%
CAPT	-	-	21	70	22	1.8
CDR	14	5	15	85	16	3.5
LCDR	8	5	9	95	10	8.3
LT	-	-	4	100	-	-

Source: Officer Management Simulation Model
Officer Professional Development
OP NAV 132, Office of the Chief of Naval Operations

However, except for LTJG's, where the promotion percentage is 100% after attrition, these percentages do not correspond directly to the promotion rate as defined above. The total number of officers promoted depends on the number actually in the promotion zone, i.e., 9 YCS for LT, 15 YCS for LCDR, and 21 YCS for CDR's. When the promotion percentage applicable to the zone is applied to the number of officers in the zone, the result is the total number of officers who may be promoted, <u>including</u> those who are promoted from <u>below the zone</u>, for example a LT with 8 YCS, and those from <u>above the zone</u>, for example a LT with 10 YCS. The actual promotion rate of officers in the zone is therefore less than the percentage quoted in the promotion plan.

The above discussion is best illustrated by an example. Suppose there are 83 LT's with 9 YCS, i.e., in the zone, 104 with 8 YCS and 12 with 10 YCS in some particular year. From Table 14, the promotion percentage for LT's in the zone is 95%. A total of 79 LT's will therefore be promoted [83 x .95 $\approx$ 79]. However, four of these, [79 x .05], will be selected from below the zone and six, [79 x .083], will be selected from above the zone. This leaves only 69, [79 - 10], to be selected from within the zone. The promotion rates for each YCS are therefore as follows:

LT (8 YCS) = 4/104 = .0385

LT (9 YCS) = 69/83 = .8313

LT (10 YCS) = 6/12 = .50

Clearly, given a constant promotion percentage the actual promotion rate for each year group will vary depending on the number of officers in the zone. For the purposes of this study, promotion rates have been calculated using the promotion percentages in Table 14 and the officer stocks shown in Section 3, Table 15. These stocks were chosen rather than the initial stocks because two years of data were available. By calculating the promotion rate for each year and then taking an unbiased average, a more stable and, hopefully, more reliable estimate was obtained. Calculations using the initial stocks of Table 13 resulted in promotion rates very close to those used, within two decimal points in most cases.

Discussions with officers familiar with the manning problems of the submarine force indicated, a priori, that the major shortages would probably occur at the LCDR level. Consequently, a second supply iteration utilizing a higher and more rapid promotion rate from LT to LCDR, was included in the analysis. This doubled the number of supply projections from three to six. Because it is not possible to significantly increase the promotion rate while the number of officers in the zone is used as a cap on the total number that may be promoted, this restriction was temporarily laid aside. Instead, in this second iteration, a constant percentage of each year group was promoted each year. The percentages, chosen quite arbitrarily, are as follows,

LT (8 YCS) ... 1%

LT (9 YCS) ... 95%

LT (10 YCS)... 75%

TABLE 15

NUCLEAR QUALIFIED SUBMARINE OFFICERS

OCT 1, 1980 AND OCT 1, 1981

YCS	LTJG 1980	LTJG 1981	LT 1980	LT 1981	LCDR 1980	LCDR 1981	CDR 1980	CDR 1981	CAPT 1980	CAPT 1981
3	390	385								
4	320	375								
5			280	277						
6			171	188						
7			140	138						
8			104	102						
9			83	91	2	1				
10			6	18	82	59				
11			1		58	80				
12					55	52				
13					83	46				
14					50	72				
15					34	43	11	14		
16					7	2	54	39		
17					1	1	46	54		
18							59	43		
19							57	51		
20							54	47		
21							39	5	7	6
22							41	3	13	16
23							4	8	32	41
24									30	29
25									17	27
26									27	16
27									17	21
28									4	14
29									3	4
30									1	3

SOURCE: Officer Management Simulation Model
Officer Professional Development
OP NAV 132, Office of the Chief of
Naval Operations

These rates in fact represent a maximum for LT's with 9 YCS. If the attrition rate of LT's with 9 YCS is 5% or greater, then 100% of those who continue will be promoted. Only if their rate of attrition falls below 5% will any officer continue as a LT with 10 YCS.

When making projections, both the planning and revised promotion rates remain fixed, regardless of the attrition rate vector being applied (see Section 3 below). Instead, the continuation rate is allowed to vary to maintain the equality with one discussed in Section 1, i.e., the sum of attrition rate plus continuation rate plus promotion rate must equal 1.0.

3. Attrition Rates

Thirdly, it is necessary to know the rate of attrition, or wastage, out of the nuclear submarine officer force. This rate is usually calculated from historical data after allowing for any atypical periods. It should also be expressed by rank and by years of commissioned service. Average rates may be used, but less accurate projections must be expected. Having calculated an historical rate, the assumption of the model is that this same rate will apply in future years.

In the analysis described below, three attrition rate vectors--high, medium and low--were applied to the initial stock of officers. Obviously, there is only one correct rate and the use of three vectors illustrates the difficulty in obtaining accurate and consistent data. All

three were calculated from data made available by different Navy sources. In all three calculations it was assumed that:

a. all LCDR's who are not promoted will attrite by the end of 22 YCS, and

b. all CDR's who are not promoted will attrite by the end of 24 YCS, and,

c. all LT's who are not promoted will attrite by the end of 11 YCS.

Other assumptions were also necessary when calculating individual vectors, but these will be discussed separately in the appropriate sections.

a. High Attrition

The attrition rate designated as "High" was calculated using the flows implied by data on the stock of nuclear qualified officers as of 1 Oct 1980 and 1 Oct 1981 (Table 15) and the planned promotion rates discussed in Section 2. Because of some inconsistencies in these data, a number of additional assumptions were necessary. If it is assumed that both of the LCDR's with 9 YCS in 1980 continued in the force in 1981, it follows that, since there were 59 LCR's with 10 YCS in 1981, 57 must have been promoted from the stock of LT's with 9 YCS as of 1 Oct 1980. This leaves 26 LT's with 9 YCS to continue as LT's in 1981 (83 - 57 = 26). However, since the actual number continuing was 18, eight must have attrited. The attrition rate of LT's with 9 YCS as of 1 Oct 1980 is therefore 8/83 = .0964. Given a planned promotion

rate of .8276 (Appendix A), their continuation rate is therefore 1 - .0964 - .8276 = .076.

Secondly, to calculate the attrition rate of LCDR's with 10 YCS it is assumed that all those attriting come from that group and not from the group of LT's with 10 YCS being promoted to LCDR. Therefore, since three officers are expected to be promoted from LT ($.5417 \times 6 \simeq 3$) and the stock of LCDR's with 10 YCS has declined from 82 to 80, then their rate of attrition becomes 5/82 = .061. Their continuation rate is then .939 (1 - .061 - 0).

Thirdly, it is assumed that LCDR's who have been passed over for promotion experience zero attrition during their 17th, 18th and 19th YCS. This is unlikely to be completely true in reality, but, given the small number of officers involved and their high propensity to continue in order to secure a pension after 20 years of service, any distortion of future stocks is expected to be negligible.

Finally, it is assumed that 100% of CDR's with 15 YCS will continue, as they have received early promotion.

Based on these special assumptions, together with the common ones presented earlier, a transition matrix showing the continuation rate, promotion rate and the attrition rate (high), for each rank by YCS may be constructed from Table 15. This matrix will be referred to as Matrix A (High Attrition). In each projection the promotion rate being applied will be stated explicitly.

b. Medium Attrition

The second attrition vector, called "Medium Attrition," was calculated from the average nuclear submarine officer cumulative continuation rates over the past five years as shown in Table 16. Since only one continuation rate is given for each YCS, there may be some bias in these figures. Officers of equal rank but different lengths of service are unlikely to experience the same rate of attrition. For example, a LT with 11 YCS who has been passed over for promotion is more likely to leave the service then a LCDR with 11 YCS whose career is progressing as expected. Consequently, an attrition rate expressed only in terms of years of commissioned service is likely to overestimate the attrition rate of LCDR's with 11 YCS and underestimate the rate for LT's with 11 YCS. However, once again, the number of officers involved is small and this simplification should not create any significant bias in the results.

The transition matrix constructed using this medium attrition vector will be referred to as "Matrix B (Medium Attrition)." In each projection the promotion rate being applied will be stated explicitly.

c. Low Attrition

The third attrition vector, called "Low Attrition" was taken directly from the planning rates used by OP132 in the Officer Management Simulation Model (see Appendix A). No additional assumptions are necessary in this case and the

TABLE 16

CUMULATIVE CONTINUATION AND ANNUAL ATTRITION RATE
FIVE YEAR HISTORICAL AVERAGE
NUCLEAR QUALIFIED SUBMARINE OFFICERS
LTJG TO CDR

YCS	CUMULATIVE CONTINUATION RATE	ANNUAL ATTRITION RATE
1	.996	.004
2	.986	.010
3	.905	.0821
4	.766	.1536
5	.500	.3473
6	.375	.2500
7	.311	.1707
8	.288	.0740
9	.274	.0486
10	.252	.0803
11-14	.196	.06
15-24	0	.05*

* See assumption ref CDR's and LCDR's past over for promotion.

SOURCE: Submarine and Nuclear Officer Program Manager, OP NAV 132, Office of the Chief of Naval Operations

transition matrix constructed will be referred to "Matrix C (Low Attrition)." Once again, the promotion rate being used will be stated explicitly for each projection.

4. Accession Rates

Generally the term "accessions" refers to the number of officers entering the nuclear submarine force training pipeline, but for the purposes of this study, "accessions" is defined as the flow of nuclear qualified submarine officers into the rank of LTJG, which is the starting point of the analysis.

In this chapter, and Chapter IV, accessions are kept constant at 400 per annum and lateral entry is not considered. During 1979, 1980 and 1981, accessions into the training pipeline were 443, 444 and 498, respectively. Historically, however, entrants suffer an average 12% attrition during training and approximately 1.4% of Ensigns attrite. The number that may be expected to reach the rank of LTJG from each of the above year groups is therefore 384, 385 and 432, respectively, or an average of 400 per annum. Assuming a constant flow of 400 per annum into the rank of LTJG presumes constant accessions into the training pipeline of approximately 461 per annum.

B. SIX SUPPLY SCENARIOS

Combining three attrition rate vectors with two promotion rates results in six transition matrices and therefore six supply projections, all of which are summarized in Table 17.

TABLE 17

PROJECTED SUPPLY - NUCLEAR QUALIFIED SUBMARINE OFFICERS
1982 - 1990

RANK	PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
CDR	I	HIGH	PLAN	230	189	161	148	154
			REVISED	230	189	161	151	165
	II	MED	PLAN	302	282	267	269	286
			REVISED	302	282	267	271	293
	III	LOW	PLAN	312	312	319	339	378
			REVISED	312	312	319	343	389
LCDR	I	HIGH	PLAN	383	378	404	434	468
			REVISED	399	410	449	487	523
	II	MED	PLAN	401	445	500	538	562
			REVISED	418	473	537	582	608
	III	LOW	PLAN	414	482	603	761	907
			REVISED	430	513	655	831	988
LT	I	HIGH	PLAN	845	943	978	992	992
			REVISED	832	929	963	975	975
	II	MED	PLAN	844	903	914	923	923
			REVISED	827	878	889	896	896
	III	LOW	PLAN	924	1169	1276	1309	1310
			REVISED	909	1144	1246	1271	1271

TABLE 17 (continued)

RANK	PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
LTJG	I	HIGH	PLAN	795	785	785	785	785
			REVISED	795	785	785	785	785
	II	MED	PLAN	777	767	767	767	767
			REVISED	777	767	767	767	767
	III	LOW	PLAN	811	800	800	800	800
			REVISED	811	800	800	800	800

The data required to construct each transition matrix are summarized in Appendix A.

1. CDR/LCDR

As expected, the high attrition rate results in a significantly smaller inventory of CDR's and LCDR's by 1990. The revised promotion rates increase the supply of both CDR's and LCDR's under all attrition rates. The impact on the supply of LCDR's is felt immediately, and by 1990 the increase in expected supply ranges from 11.8% under the high attrition vector to 8% under medium attrition. Because of a lag, as the increased supply of LCDR's gains service time in that rank, the impact of the increased rate of promotion from LT to LCDR is not felt at the CDR level until 1988. By 1990, the expected supply of CDR's has increased by between seven and two percent, depending upon the rate of attrition. This difference can be expected to increase beyond 1990 as an increasing number of LCDR's move into the CDR ranks and total supply approaches steady state.

2. LT/LTJG

With LT's and LTJG's, the impact of different attrition and promotion vectors is less clear-cut. The attrition vector that has been termed "medium attrition" results in a lower expected supply than the so-called high attrition vector for both ranks. In the case of LT's, lower attrition results in a significantly greater expected supply by 1990, but a much smaller difference in expected supply for LTJG's; a maximum

of 33 out of a total of between 767 and 800. Obviously the increased rate of promotion from LT to LCDR does not affect the expected supply of LTJG's, but it does result in a small reduction in the expected supply of LT's, ranging from 17 to a maximum of 38. The difference between the most optimistic supply scenario, i.e., low attrition and the planned promotion rates, and the most pessimistic, i.e., medium attrition and revised promotion rates; is 414 for LT's, but only 33 for LTJG's.

IV. SUPPLY VS DEMAND

A. PROJECTED SUPPLY/DEMAND IMBALANCES

By applying six supply projections against four demand projections, 24 quite different forecasts of future supply/demand imbalances are obtained. This provides something of a smorgasbord of results, but one must remember the assumptions upon which each projection is based. It is not the intention of this thesis to identify one outcome as "the" future manning situation. No attempt is made to arrive at a single "correct" prediction. Instead, the reader is asked to critically assess the assumptions underlying each projection, and, exercising his own judgment, to accept that projection which, in his opinion, is likely to be the most accurate. All possible outcomes have been summarized in Tables 18, 19, 20 and 21.

1. CDR

Because all CDR positions require a nuclear qualified officer, the level of demand for CDR's is not affected by the high/low manning assumption discussed in Chapter II. It varies only with the assumed sea/shore rotation ratio. Consequently, demand levels A and C, both low sea/shore rotation ratios, are the same while demand levels B and D, both high rotation ratios, are also equal. To avoid unnecessary detail these equal levels have been grouped in Table 18.

By 1990 the projected imbalance in the supply of CDR's ranges from a shortage of 208 officers under a low rotation

TABLE 18

PROJECTED SUPPLY/DEMAND IMBALANCES: 1982-1990

CDR [SHORTAGE]

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
LOW RATIO	I	HIGH	PLAN	[72]	[133]	[169]	[200]	[208]
			REVISED	[72]	[133]	[169]	[197]	[197]
(A/C)	II	MED	PLAN	0	[40]	[63]	[79]	[76]
			REVISED	0	[40]	[63]	[77]	[69]
	III	LOW	PLAN	10	[10]	[11]	[9]	16
			REVISED	10	[10]	[11]	[5]	27
HIGH RATIO	I	HIGH	PLAN	[34]	[93]	[128]	[156]	[163]
			REVISED	[34]	[93]	[128]	[153]	[152]
(B/D)	II	MED	PLAN	[38]	[0]	[22]	[35]	[31]
			REVISED	[38]	[0]	[22]	[33]	[24]
	III	LOW	PLAN	48	30	30	35	61
			REVISED	48	30	30	39	72

ratio, high attrition and the planned promotion rate, to a surplus of 72 officers under a high rotation ratio, low attrition and the revised promotion rate.

Applying the high rotation ratio has a greater impact than does changing the promotion rate. By 1990 the high rotation ratio reduces the shortfall by 45 officers under all attrition vectors, against between 7 and 11 if only the promotion rate is changed. In addition, the impact of the high rotation ratio is felt immediately. Increasing the promotion rate from LT to LCDR does not affect the supply of CDR's until 1988. By far the most influential factor is the attrition vector accepted. Accepting the low attrition vector rather than the high converts a large shortage, 208 in 1990, into a surplus of 16 under otherwise identical conditions. In the short term at least (1982 through 1990), it appears that reducing the rate of attrition and accepting a high sea/shore rotation ratio will be necessary to combat shortages in the CDR ranks.

2. <u>LCDR</u>

By far the greatest shortages are projected to occur at the LCDR level (Table 19). Only under the optimistic low attrition vector do any surpluses appear and, once again, the attrition vector accepted is the dominant factor. Under the highest level of demand, high manning/low ratio, accepting the low attrition vector over the high converts a projected shortage of 424 officers in 1990 to a surplus of 15 under

TABLE 19

PROJECTED SUPPLY/DEMAND IMBALANCES: 1982-1990

LCDR [SHORTAGE]

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
HIGH MANNING + LOW RATIO (A)	I	HIGH	PLAN	[375]	[426]	[410]	[422]	[424]
			REVISED	[359]	[394]	[365]	[369]	[369]
	II	MED	PLAN	[357]	[359]	[314]	[318]	[330]
			REVISED	[340]	[331]	[277]	[274]	[284]
	III	LOW	PLAN	[344]	[322]	[211]	[95]	15
			REVISED	[328]	[291]	[159]	[25]	96
HIGH MANNING + HIGH RATIO (B)	I	HIGH	PLAN	[249]	[292]	[274]	[279]	[275]
			REVISED	[233]	[260]	[229]	[226]	[220]
	II	MED	PLAN	[231]	[225]	[178]	[175]	[181]
			REVISED	[214]	[197]	[141]	[131]	[135]
	III	LOW	PLAN	[218]	[188]	[75]	48	164
			REVISED	[202]	[157]	[23]	118	245
LOW MANNING + LOW RATIO (C)	I	HIGH	PLAN	[217]	[256]	[240]	[238]	[224]
			REVISED	[201]	[222]	[195]	[185]	[169]
	II	MED	PLAN	[199]	[187]	[144]	[134]	[130]
			REVISED	[182]	[159]	[107]	[90]	[84]
	III	LOW	PLAN	[186]	[150]	[41]	89	215
			REVISED	[170]	[119]	11	159	296

TABLE 19 (continued)

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
LOW MANNING + HIGH RATIO (D)	I	HIGH	PLAN	[117]	[149]	[133]	[126]	[109]
			REVISED	[101]	[117]	[88]	[73]	[54]
	II	MED	PLAN	[99]	[82]	[37]	[22]	[15]
			REVISED	[82]	[54]	0	22	31
	III	LOW	PLAN	[86]	[45]	66	201	330
			REVISED	[70]	[14]	118	271	411

otherwise identical conditions. If the other demand reducing assumptions are also accepted, i.e., low manning/high ratio, then the shortage is converted into an equally large projected surplus of 411 officers. In every scenario, the low attrition vector converts an initial shortage in 1982 into a projected surplus by 1990. Under demand level A, high manning/low ratio, the low attrition vector is able to convert a shortage of 328 officers in 1982 into a projected surplus of 96 by 1990. Such a large change casts some doubt on the accuracy of the low attrition vector and leads one to question its validity as a planning device. It does, however, graphically illustrate the potential benefits of reducing attrition. By 1990 the difference in the projected shortage under the high and medium attrition vectors is around 100 officers, and this seems realistic. In spite of increasing demand throughout the decade, the shortage of LCDR's in fact declines under both the medium and low attrition vectors. The shortage increases under high attrition, but, except for at the maximum demand level, demand A, this increase can be reversed by adopting the revised promotion rate.

Maximizing the promotion rate from LT to LCDR results in some increase in the supply of LCDR's. By 1990, this increase ranges from 81 under the low attrition vector to 46 under conditions of medium attrition. Under the high attrition vector, the gain is 55, but the shortages are still the greatest in absolute terms. Also, they persist until 1990

in all high attrition scenarios. Even if the medium attrition vector is accepted, shortages persist in all scenarios except against the lowest demand level, i.e., low manning/ high ratio. Under the low attrition vector, surpluses are projected in all scenarios regardless of which promotion rate policy is adopted. Once again, it appears that in the absence of lateral entry, the only short-term solution to the LCDR shortage is reduced attrition.

3. LT

Even with accessions held constant at historical levels, there is no shortage in the supply of LT's until 1988. Even then, the projected shortfall is very small and occurs only under conditions of maximum demand (Table 20).

Again, the attrition vector accepted has a significant impact on projected supply-demand imbalances. The low attrition vector results in very optimistic supply projections even in the highest demand scenario. Accepting the low attrition vector converts a maximum projected shortage of 86 under medium attrition to a surplus of 289 under otherwise identical conditions. Most scenarios project an increasing surplus of LT's until 1986 followed by a decline through 1990. By 1990, under high manning demand, both the high and medium attrition vectors project a smaller surplus than in 1982, or even a shortfall, while the low attrition vector projects an increase in supply under all demand conditions. Under the low manning assumption, both the high and low attrition vectors

TABLE 20

PROJECTED SUPPLY/DEMAND IMBALANCES: 1982-1990

LT [SHORTAGE]

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
HIGH MANNING	I	HIGH	PLAN	85	113	110	60	10
+			REVISED	72	99	95	43	[7]
LOW	II	MED	PLAN	84	73	46	[9]	[59]
RATIO			REVISED	67	48	21	[36]	[86]
(A)	III	LOW	PLAN	164	339	408	377	328
			REVISED	149	314	378	339	289
HIGH MANNING	I	HIGH	PLAN	212	251	255	215	174
+			REVISED	199	237	240	198	157
HIGH	II	MED	PLAN	211	211	191	146	105
RATIO			REVISED	194	186	166	119	78
(B)	III	LOW	PLAN	291	477	553	532	492
			REVISED	276	452	523	494	453
LOW MANNING	I	HIGH	PLAN	539	609	632	620	598
+			REVISED	526	595	617	603	581
LOW	II	MED	PLAN	538	569	568	551	529
RATIO			REVISED	521	544	543	525	502
(C)	III	LOW	PLAN	618	835	930	937	916
			REVISED	603	810	900	899	887

TABLE 20 (continued)

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	PROMOTION RATE	BIENNIAL PROJECTION 1982	1984	1986	1988	1990
LOW MANNING	I	HIGH	PLAN	590	665	690	682	664
+			REVISED	577	651	675	665	647
HIGH	II	MED	PLAN	589	625	626	613	595
RATIO			REVISED	572	600	601	586	568
(D)	III	LOW	PLAN	669	891	988	999	982
			REVISED	654	866	958	961	943

project an increased surplus by 1990, while the medium attrition vector projects a small decline. Depending upon the attrition vector accepted, increasing the promotion rate decreases the supply of LT's by between 17 and 39 by 1990.

In contrast with the situation for CDR's and LCDR's, the manning assumption accepted is a very important factor in this case. This is because the majority of positions deleted as not requiring a nuclear qualified incumbent are LT positions (Table 3). Accepting the low manning assumption reduces the demand for nuclear qualified LT's by almost 600 officers in 1990, compared with a reduction of only 200 in the demand for nuclear qualified LCDR's. At first, this suggests that deleting the requirement that these positions be filled by nuclear qualified officers may be an expedient way of reducing demand. Unfortunately this would have an undesirable long-term effect on the supply of nuclear qualified LCDR's who are in short-supply even under the low manning assumption.

4. <u>LTJG</u>

Because it is expected that a LTJG will spend all of his time in that rank at sea, there is no rotation demand for LTJG's (Table 7). The total demand for LTJG's will therefore vary only according to the manning assumption accepted. As a result, demand levels A and B, both high manning, are the same, while demand levels C and D, both low manning, are also equal. To avoid unnecessary detail these equal levels of

demand have been grouped in Table 21. Because changing the promotion rate from LT to LCDR does not affect the supply of LTJG's this column has also been delted from the table.

A surplus of LTJG's is projected under all attrition vectors. In this case the attrition vector accepted does not have a significant impact, while the manning assumption accepted has a major impact, reducing demand by 340 officers in 1990. For the same reasons discussed in Section 3, the low manning level is not, however, an attractive policy option. Reducing the supply of nuclear qualified LTJG's will only exacerbate the shortage of nuclear qualified LCDR's in later years.

Because supply reaches steady state as early as 1984, the projected surplus declines steadily through to 1990 as demand increases with the increasing size of the fleet. Nevertheless, with a surplus projected in all scenarios considered, it does not appear that the supply of LTJG's will be a problem during the 1980's if historical accession rates can be maintained.

B. SOME PRELIMINARY CONCLUSIONS

From the data of Tables 20 and 21, it does not appear that the supply of junior officers will be a major problem during the 1980's. As indicated a priori, the most serious shortages are expected to occur at the LCDR rank and the greatest potential for increasing supply lies in reduced attrition.

TABLE 21

PROJECTED SUPPLY/DEMAND IMBALANCES: 1982-1990

LTJG [SHORTAGE]

DEMAND PROJECTION	SUPPLY PROJECTION	ATTRITION VECTOR	BIENNIAL PROJECTION; 1982	1984	1986	1988	1990
HIGH MANNING (A/B)	I	HIGH	200	153	139	107	83
	II	MED	182	135	121	89	65
	III	LOW	216	168	154	122	98
LOW MANNING (C/D)	I	HIGH	493	463	455	437	423
	II	MED	475	445	437	419	405
	III	LOW	509	478	470	452	438

In spite of the relatively healthy supply of junior officers, the LCDR and CDR shortages are projected to persist to 1990 and beyond unless the low attrition vector is accepted as an accurate reflection of reality. However, given the recent history of officer manpower shortages in the nuclear submarine force, the very size of the surpluses generated by this vector lead one to question whether it accurately reflects historical attrition rates, or even what may reasonably be expected to be achieved in the future.

Because the first shortages appear at the LCDR level in all scenarios, increasing the number of accessions into the Ensign rank is not the answer to the manning problems of the 1980's. Even if the size of the 1982 graduating class could somehow be increased, these graduates would not reach LCDR rank until at least 1990.

The surplus of LT's indicates that it may be possible to reduce the sea/shore rotation ratio for these officers and, perhaps, thereby reduce their attrition rate. This, in time, would increase the supply of LCDR's allowing a reduction in their sea/shore rotation ratio and so on until eventually an improved supply of CDR's allows a reduction in their sea/shore rotation ratio also. Whether such a policy would have a significant impact, and how fast that impact would move upward through the system, are questions for further research.

Alternatively, the supply of LCDR's could be increased by increasing even further the percentage of LT's with 8 YCS selected for early promotion, or even by allowing LT's to

fill LCDR positions. However, promotions which are too rapid will lower the general experience level of LT's. The impact of increased promotion rates on the supply of LCDR's is marginal at best and does not affect the supply of CDR's at all until 1988.

Accepting the low manning assumption is not a viable long-term policy option because of the distribution of shortages across different ranks. The low manning assumption has its greatest impact at the LT level where there are no shortages even under high demand conditions. The demand for nuclear qualified LCDR's is reduced considerably under this assumption, but shortages persist. Consequently, with low manning demand levels it would still be necessary to train a surplus of nuclear qualified junior officers to meet the demand for nuclear qualified LCDR's in later years. Because there is also a projected shortage of CDR's, who must be nuclear qualified, it is not possible to reduce the supply of nuclear qualified LCDR's without exacerbating this shortage. Quite the reverse, because of the closed nature of the promotion system the number of nuclear qualified LCDR's in the system will have to be increased if the shortage of CDR's is to be eliminated.

The projected shortage of nuclear qualified LCDR's, even under the low manning assumption, indicates that, in the absence of any lateral entry program, the continued use of non-nuclear qualified officers will be necessary during the 1980's.

V. ALTERNATIVE ACCESSION POLICIES

In the analysis of Chapters III and IV, accessions were kept constant at 400 per annum and only the period 1982-1990 was examined. In this chapter, this accession rate is varied in order to explore the impact of increased accessions on supply/demand imbalances, and the period 1982-1997 is examined in an attempt to establish an optimum accession policy for the long term. In Section A, policies involving accessions into the rank of LTJG only are considered. In Section B, policies including some lateral entry are examined. At this point the reader is reminded that the term "accessions" is defined as the flow of nuclear qualified submarine officers into the rank of LTJG. To obtain an estimate of the number of Ensigns who must enter the nuclear training pipeline, required accessions, as calculated in this chapter, should be increased by approximately 15.5% to allow for attrition both during training and during service as an Ensign.

The analysis that follows can be applied to any of the 24 supply/demand combinations developed in previous chapters, but space limitations preclude this approach. Instead, the author has chosen to accept his own advice and one scenario is selected as the most probable. The scenario studied matches demand level B (high manning/high ratio) against projected supply under the medium attrition vector and revised rates of promotion. A number of alternative accession policies are

assessed on the basis of their capacity to redress the shortages projected under this single sceanrio.

As discussed in Chapter IV, the low manning assumption is not considered to be an attractive policy option on which to base future manpower planning. The high manning assumption has therefore been accepted. It is possible of course, that some compromise between the high and low manning levels is possible, but this requires study by a researcher more familiar than the author with the requirements of each officer billet. Ideally, a low sea/shore rotation ratio is desirable, but after considering the demands that are likely to be made on the nuclear submarine force during the 1980's, a pragmatic approach is taken and the less desirable high rotation ratio accepted as likely to be necessary for some time. In addition, it is assumed that the size and composition of the fleet, and therefore total demand, will remain constant from 1990.

On the supply side, the medium attrition vector is accepted because it reflects actual historical data averaged over five years. As such it is likely to be more accurate than the high attrition vector which is based on a single flow between 1980 and 1981. As was also discussed in Chapter IV, the low attrition vector results in such optimistic forecasts that its accuracy is suspect. The revised promotion rate is also accepted because the promotion rate is a policy variable that may readily be changed by political decision. Given the quality of officers traditionally entering the nuclear

submarine force, a very high rate of promotion to LCDR rank should be possible without any reduction in performance standards.

A. NO LATERAL ENTRY

In this section, three alternative accession rates, high, medium and low, are considered. All are expressed at an annual rate and assume entry into the rank of LTJG only (Table 22).

TABLE 22

ALTERNATIVE ACCESSION RATES

		1982	1983	1984	1985	1986	1987	→
Accession Rate	HIGH	400	400	450	500	550	600	→
	MED	400	400	450	500	500	500	→
	LOW	400	400	400	400	400	400	→

The low accession rate simply maintains total accessions at the historical level of 400 per annum. The imbalances projected, at least as far as 1990, are therefore the same as those discussed in Chapter IV. The medium rate assumes that the number of accessions can be increased by 50 per annum to a maximum of 500 per annum and then held constant at that level. The high rate assumes that the number of accessions can be increased by 50 per annum to a maximum of 600 per annum and then held constant. The annual increase is

held to 50 per annum because it is considered that this is more realistic than assuming a sudden jump to the desired level in only one year. Note also that the increases do not begin until 1984. The officers who will be entering the LTJG rank during 1982 and 1983 have already been recruited and no increase in this figure is possible. The aim here is not only to explore the impact of increased accessions, but to do so using hypothesized accession rates that represent feasible policy options. The supply/demand imbalances projected under each accession rate are summarized in Table 23. The projected supply, by rank, under each accession rate is also shown in Table 24. Total demand for the period 1982-1990 is the same as calculated in Chapter II (Table 12) and is assumed to remain constant after 1990.

1. CDR

The imbalance in the supply of CDR's is unaffected by the accession rate before 1997. Increasing accessions is therefore an ineffective way of attacking the shortage of CDR's. By 1993 a surplus in the supply of CDR's is projected regardless of the accession rate, and the surplus is projected to increase as the system apporaches steady state. In steady state the surplus ranges from a maximum of 259 under the high accession rate down to 67 under the low accession rate.

2. LCDR

The imbalance in the supply of LCDR's is unaffected by the accession rate before 1990. Increasing the number of

TABLE 23

PROJECTED SURPLUS/SHORTAGE UNDER VARIOUS ACCESSION RATES

1982 - 1997 [SHORTAGE]

RANK	ACCESSION RATE	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
	HIGH	38	0	[22]	[33]	[24]	[3]	23	49	67	259
CDR	MED	38	0	[22]	[33]	[24]	[3]	23	49	67	164
	LOW	38	0	[22]	[33]	[24]	[3]	23	49	59	67
	HIGH	[214]	[197]	[141]	[131]	[134]	[114]	[30]	67	145	201
LCDR	MED	[214]	[197]	[141]	[131]	[134]	[114]	[47]	0	33	45
	LOW	[214]	[197]	[141]	[131]	[135]	[131]	[116]	[114]	[113]	[112]
	HIGH	194	186	205	305	436	483	525	525	525	525
LT	MED	194	186	205	266	289	302	302	302	302	302
	LOW	194	186	166	119	78	78	78	78	78	78
	HIGH	182	185	413	473	449	449	449	449	449	449
LTJG	MED	182	185	313	281	257	257	257	257	257	257
	LOW	182	135	121	89	65	65	65	65	65	65

TABLE 24

PROJECTED SUPPLY UNDER VARIOUS ACCESSION RATES

RANK	ACCESSION RATE	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
	HIGH	302	282	267	271	293	314	340	366	384	576
CDR	MED	302	282	267	271	293	314	340	366	384	481
	LOW	302	282	267	271	293	314	340	366	376	384
	HIGH	418	473	537	582	609	629	713	810	888	944
LCDR	MED	418	473	537	582	609	629	696	743	776	788
	LOW	418	473	537	582	608	612	627	629	630	631
	HIGH	827	878	928	1082	1254	1301	1343	1343	1343	1343
LT	MED	827	878	928	1043	1107	1120	1120	1120	1120	1120
	LOW	827	878	889	896	896	896	896	896	896	896
	HIGH	777	817	1059	1151	1151	1151	1151	1151	1151	1151
LTJG	MED	777	817	959	959	959	959	959	959	959	959
	LOW	777	767	767	767	767	767	767	767	767	767

accessions is therefore an ineffective way of attacking the shortage of LCDR's, at least during the 1980's. After 1990 the alternative accession policies begin to have a differential effect. Under the high accession rate, a sizeable surplus is projected by 1995, and the system achieves steady state with a surplus of 201 LCDR's. Under the medium accession rate surpluses appear later and are not so large. The first surplus projected is 33 in 1997, after which steady state is achieved with a surplus of only 45 officers. If the current low accession rate is maintained, then shortages may be expected to continue indefinitely. At an accession rate of 400 per annum, the shortage of LCDR's is projected to decline to 113 by 1997, but to remain around that figure even in steady state. If the shortage of LCDR's is attacked by varying the accession rate, then not only must the number of accessions be increased, but a considerable time lag before the shortage is eliminated, must be accepted.

3. LT and LTJG

The projected supply of both LT's and LTJG's increases steadily under all accession rates until steady state is achieved. However, because of increasing demand during the 1980's, the projected surplus increases at a slower rate, and even declines under the low accession rate. Under both the high and medium accession rates, the projected surplus of LT's increases steadily from 1984 until steady state is achieved. The surplus of LTJG's peaks in 1988 under the high

accession rate, and in 1986 under the medium accession rate, before declining slightly to its steady state level in 1990. Although the projected supply/demand imbalances can not reach steady state before 1990 when demand stabilizes, a surplus is projected in steady state for both ranks. Under the low accession rate, the projected surplus is not large, but under both the medium and high accession rate, a large surplus is projected for both LT's and LTJG's.

B. LATERAL ENTRY POLICIES

In the final paragraph of Chapter IV, it was concluded that the continued use of non-nuclear qualified LCDR's will be necessary during the 1980's unless some type of lateral entry program is implemented. The analysis of Section A of this chapter also suggests that unless accessions can be increased above their present level of 400 per annum, such a program of lateral entry will be required indefinitely. In the analysis that follows, a number of possible lateral entry policies are examined and their impact on the supply/demand imbalance in the LCDR and CDR ranks over the period 1982-1997 is assessed. Because no shortages appear below the rank of LCDR regardless of the assumed conditions of supply and demand, the policies considered have been restricted to lateral entry at LCDR level only. In practice, more junior officers could be recruited laterally, but this would delay the impact of the program on the supply of LCDR's where the need is most urgent. Entry at CDR level is not considered

because lateral entry into a Commanding Officer's billet does not seem to be a practical alternative unless of course lateral entry from the Navy Reserve is accepted. Lateral entry at the LCDR level will have an impact on the supply of CDR's after a time lag. The length of this lag will depend on the seniority of those LCDR's entering through the lateral entry program. In the following analysis it has been assumed that these LCDR's recruited laterally join the submarine force during their 10th YCS. No impact on the supply of CDR's can therefore be expected for at least six years, regardless of the particular lateral entry policy implemented.

If either the medium or high accession rates can be achieved, then a lateral entry program will be needed only to combat the shortages projected for the period 1982-1993 (refer to Table 23). Lateral entry can provide a short term solution while the impact of the increased number of accessions moves upward through the system finally eliminating shortages even at the CDR level. Four possible lateral entry policies of finite duration, designed to eliminate these shortages, have therefore been incorporated into each of the three accession policies discussed in Section A. These are policy numbers I, II, III and IV in Table 25. If, however, accessions remain at the low level of 400 per annum, a continuing lateral entry program will be required to maintain a sufficient supply of nuclear qualified LCDR's. With the aid of the MANMOD model this question was addressed iteratively and two suggested continuing lateral entry policies designed to

TABLE 25

POSSIBLE LATERAL ENTRY POLICIES

ANNUAL ACCESSIONS

ENTRY TO LCDR ONLY

	POLICY NUMBER	1983	1984	1985	1986	1987	1988	...
LATERAL	I	200	--	--	--	--	--	
	II	100	100	--	--	--	--	
ENTRY	III	50	50	50	50	--	--	
	IV	100	50	50	50	50	--	
POLICY	V	100	50	50	30	30	30	...
	VI	50	50	50	50	30	30	...

maintain the required supply of LCDR's under a low accession rate are included in the analysis. These are listed as policy numbers V and VI in Table 25.

In all, there are 14 possible projections to be considered. Combining four short term lateral entry policies with three accession rates results in 12 alternative projections. To these must be added the two continuous lateral entry programs incorporated with the low accession rate, giving a total of 14 projections. All 14 are summarized for CDR in Table 26, and for LCDR in Table 27. The projected supply under each combination of accession rate and lateral entry program is also given for both CDR's and LCDR's in Tables 28 and 29, respectively.

The systematic analysis of this many options may be approached in two ways. The first approach emphasizes the importance of the accession rate. It is suggested that the reader first decide which accession rate appears to be the most realistic in terms of achievability and cost. Once this is decided, each lateral entry policy may be compared within the framework of that accession rate and the optimal policy selected. Alternatively, the most acceptable lateral entry policy may be determined using whatever criteria are appropriate. The lowest accession rate that, in combination with this lateral entry policy, provides the necessary supply may then be adopted as policy.

TABLE 26

PROJECTED SURPLUS/SHORTAGE OF CDR'S UNDER VARIOUS ACCESSION RATES AND LATERAL ENTRY POLICIES [SHORTAGE]

1982-1997

ACCESSION RATE	LATERAL ENTRY POLICY	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
LOW	I	38	0	[22]	[33]	85	105	120	133	85	67
	II	38	0	[22]	[33]	67	105	123	137	86	67
	III	38	0	[22]	[33]	5	52	127	142	116	67
	IV	38	0	[22]	[33]	32	79	152	190	147	67
	V	38	0	[22]	[33]	32	79	141	186	176	166
	VI	38	0	[22]	[33]	5	52	127	175	178	166
MEDIUM	I	38	0	[22]	[33]	85	105	120	133	93	163
	II	38	0	[22]	[33]	33	105	123	137	94	163
	III	38	0	[22]	[33]	5	52	127	142	125	163
	IV	38	0	[22]	[33]	32	79	152	190	155	163
HIGH	I	38	0	[22]	[33]	85	105	120	133	93	259
	II	38	0	[22]	[33]	33	105	123	137	94	259
	III	38	0	[22]	[33]	5	52	127	142	125	259
	IV	38	0	[22]	[33]	32	79	152	190	155	259

TABLE 27

PROJECTED SURPLUS/SHORTAGE OF LCDR'S UNDER VARIOUS
ACCESSION RATES AND LATERAL ENTRY POLICIES [SHORTAGE]
1982-1997

ACCESSION RATE	LATERAL ENTRY POLICY	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
LOW	I	[214]	[6]	24	13	[113]	[114]	[101]	[106]	[113]	[112]
	II	[214]	[1]	29	18	[58]	[111]	[100]	[103]	[111]	[112]
	III	[214]	[99]	42	28	[22]	[51]	[98]	[101]	[107]	[112]
	IV	[214]	[51]	83	112	25	[8]	[61]	[94]	[103]	[112]
	V	[214]	[51]	63	105	78	71	78	80	77	77
	VI	[214]	[99]	42	87	87	82	76	80	78	77
MEDIUM	I	[214]	[6]	24	13	[112]	[97]	[32]	8	32	46
	II	[214]	[1]	29	18	[57]	[94]	[32]	11	34	46
	III	[214]	[99]	42	28	[21]	[34]	[30]	13	39	46
	IV	[214]	[51]	83	112	26	9	7	19	43	46
HIGH	I	[214]	[6]	24	13	[112]	[97]	[15]	77	146	203
	II	[214]	[1]	29	18	[57]	[94]	[15]	79	148	203
	III	[214]	[99]	42	28	[21]	[34]	[13]	81	152	203
	IV	[214]	[51]	83	112	26	9	24	88	156	203

TABLE 28

PROJECTED SUPPLY OF CDR'S UNDER VARIOUS
ACCESSION RATES AND LATERAL ENTRY POLICIES
1982-1997

ACCESSION RATE	LATERAL ENTRY POLICY	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
LOW	I	302	282	267	271	402	422	437	450	402	384
	II	302	282	267	271	350	422	440	454	403	384
	III	302	282	267	271	322	369	444	459	433	384
	IV	302	282	267	271	349	396	469	507	464	384
	V	302	282	267	271	349	396	458	503	493	483
	VI	302	282	267	271	322	369	444	492	495	483
MEDIUM	I	302	282	267	271	402	422	437	450	410	480
	II	302	282	267	271	350	422	440	454	411	480
	III	302	282	267	271	322	369	444	459	442	480
	IV	302	282	267	271	349	396	469	507	472	480
HIGH	I	302	282	267	271	402	422	437	450	410	576
	II	302	282	267	271	350	422	440	454	411	576
	III	302	282	267	271	322	369	444	459	442	576
	IV	302	282	267	271	349	396	469	507	472	576

TABLE 29

PROJECTED SUPPLY OF LCDR'S UNDER VARIOUS

ACCESSION RATES AND LATERAL ENTRY POLICIES

1982-1997

ACCESSION RATE	LATERAL ENTRY RATE	1982	1984	1986	1988	1990	1991	1993	1995	1997	STEADY STATE
LOW	I	418	664	702	726	630	629	642	637	630	631
	II	418	669	707	731	685	632	643	640	632	631
	III	418	571	720	741	721	692	645	642	636	631
	IV	418	619	761	825	768	735	682	649	640	631
	V	418	619	741	818	821	814	821	823	820	820
	VI	418	571	720	800	830	825	819	823	821	820
MEDIUM	I	418	664	702	726	631	646	711	751	775	789
	II	418	669	707	731	686	649	711	754	777	789
	III	418	571	720	741	722	709	713	756	782	789
	IV	418	619	761	825	769	752	750	762	786	789
HIGH	I	418	664	702	726	631	646	728	820	889	946
	II	418	669	707	731	686	649	728	822	891	946
	III	418	571	720	741	722	709	730	824	895	946
	IV	418	619	761	825	769	752	767	831	899	946

1. CDR

As expected, there is no impact on the supply of CDR's before 1990 regardless of which combination of accession rate and lateral entry policy is considered. However, from 1990 a surplus of CDR's is projected under all combinations. From 1990 all combinations except one result in an increasing supply, moving towards a peak in 1995. The exception is the combination of the low accession rate and lateral entry policy number VI which peaks in 1997. If the low accession rate is maintained, supply is projected to decline after 1995, but a surplus is maintained regardless of the lateral entry policy. Policy numbers I to IV result in a projected steady state surplus of 67. Policy numbers V and VI result in a higher projected surplus of 166 because of the continuing nature of these programs. Under both the medium and high accession rates, supply dips after 1997 but rises again to a steady state surplus of 163 and 259, respectively. Since policies I to IV are of finite length, the final steady state surplus depends only on the accession rate and is therefore higher the greater the number of accessions into LTJG.

2. LCDR

Because of the time lag between an individual's date of entry in the rank of LTJG and his reaching the rank of LCDR it is 1990 before the various accession rates begin to have a differential impact.

Although the speed with which shortages are eliminated depends on the size of the initial intake of officers, all

lateral entry policies are projected to eliminate the shortage of LCDR's by 1986 regardless of the accession rate. However, from 1990 the situation is more complex and under most policy combinations, shortages reappear during the 1990's. Whether these shortages persist depends upon the accession rate.

a. Low Accession Rate

Although lateral entry policies I, II, III and IV are projected to eliminate the shortage of LCDR's by 1986, these programs are of finite length and terminate well before the end of the 1980's. The initial increase in supply simply moves through and out of the LCDR rank without being replaced. As a result, shortages reappear by 1990 and continue to grow until the same steady state shortage of 112 officers, as projected in Section A, Table 23, is again achieved. The shorter the duration of the lateral entry program the earlier the shortages reappear and the more rapid the approach to steady state. By contrast, because of their continuing nature, lateral entry policy numbers V and VI not only achieve surpluses by 1986, but these surpluses are projected to continue in steady state. If these policies were to be combined with medium or high accession rates, the projected surpluses would be higher but the general pattern of shortages followed by surpluses would be the same.

b. Medium Accession Rate

If the medium accession rate is maintained, shortages are projected to reappear under lateral entry policy numbers

I, II and III. Once again the increased supply provided by the lateral entry program has moved through and out of the system before the impact of the increasing number of accessions reaches the LCDR level. By 1995 a surplus is again projected as the increasing number of officers entering as LTJG's reach LCDR rank. This surplus is projected to increase to 46 in steady state.

On the other hand, lateral entry policy number IV is of longer duration, and a surplus is projected for all years from 1986. By continuing the lateral entry program for an additional year, the impact of increased accessions on the supply of LCDR's is felt before the additional supply generated by the lateral entry program leaves the system. Under the medium accession rate, lateral entry policy number IV is the only policy for which a continuous surplus is projected from 1986, although all four eventually achieve the same steady state surplus. This occurs because all four programs are of a finite duration. In steady state, the only determinant of supply is the accession rate.

c. High Accession Rate

The projections under the high accession rate are the same as those under the medium accession rate until 1993 when the impact of the higher accession rate begins to be felt. All shortages are eliminated by 1986 regardless of the lateral entry policy implemented. Under policy numbers I, II and III, for the same reasons discussed in Section 2.b, shortages reappear in 1990 but are eliminated again by 1995.

Because the effect of the higher accession rate is now being felt on total supply, the projected shortages in 1993 are smaller than under the medium accession rate, and the surplus is projected to be larger for every year from 1995. As was the case under the medium accession rate, and again for the same reason, policy number IV is projected to achieve a surplus for every year from 1986.

C. SOME PRELIMINARY CONCLUSIONS

In the long term, beyond 1991, all shortages can be eliminated simply by increasing the accession rate. Even if the number of accessions remains at the current level of 400 per annum, long term shortages persist only at the LCDR level. Nevertheless, as was indicated in the analysis of Chapter IV, increasing the number of officers entering the rank of LTJG will not, on its own, reduce the critical shortage of CDR's and LCDR's between 1982 and the early 1990's. A possibly undesirable side effect of increased accessions is an increasingly large surplus of LT's and LTJG's. The very size of these surpluses indicates that the officer manpower requirements of the nuclear submarine force, as dictated by the current SMD's, do not conform with the classical pyramid structure. A relatively large number of LCDR's is required compared with the demand for junior officers and even CDR's (see Table 12). As a result, any accession rate which is sufficient to eliminate the shortage of LCDR',s also results in significant surpluses in the supply of LT's and LTJG's, and, to a lesser extent, in the supply of CDR's. Whether

the nuclear submarine force can absorb a surplus of up to 500 LT's and 450 LTJG's is beyond the ken of the author.

It is clear that if the shortage of LCDR's projected for the 1980's is to be eliminated, some type of lateral entry program is necessary. No lateral entry policy short of entry directly at CDR rank, or very senior LCDR, can affect the projected shortage of CDR's in the years 1986 to 1988. How extensive any lateral entry program needs to be depends on the accession rate. If the number of accessions remains at 400 per annum, then a continuing policy of recruiting at least 30 officers per year through a lateral entry program will be required indefinitely. The figure of 30 per annum assumes that up to 200 officers can be recruited in the first two to three years of the program to rapidly eliminate the current shortage of around 200. Approximately 30 per annum will be required thereafter to prevent shortages from reappearing.

If the accession rate can be increased, such programs need only be of limited duration. Even without a lateral entry program, surpluses are projected by 1995 under the medium and high accession rates. Any lateral entry program would only be required to cover the shortfall in supply until the impact of the increased number of accessions into the rank of LTJG reaches LCDR level. The analysis of this chapter indicates that a lateral entry program would need to run until about 1987 under these conditions.

VI. FUTURE SUPPLY

Having established an optimum accession policy, or at least a range of options, the next question is whether it is going to be possible to recruit the required number of officer candidates. As discussed in Chapter I, there have been no studies so far as the author is aware on projected officer supply during the 1980's. To date, officer manning studies have assumed that the required number of officer candidates will be available and that any supply constraints will be in the size of the training pipeline or because of budgetary restrictions.

These restrictions can of course be very real, but this thesis addresses the more basic supply question. For the years 1979 to 1981, accessions into the nuclear submarine program averaged 461 per annum. In each year the force fell short of its accession goals by 237, 211 and 156, respectively, and the projected shortfall for 1982 is 193. It should be remembered at this point that these figures represent the number of new officer graduates entering the nuclear-submarine-force training pipeline, not the number of entrants into the force itself. Accessions into the rank of LTJG, the start point for the analysis presented here, have averaged 400 per annum over the same period, as discussed in Chapter III, Section A. Given the accession goals that are necessary, it seems that the real constraint on the supply of officer candidates

during the 1980's may not be the size of the training pipeline, or even budgetary restrictions, but the Navy's inability to attract sufficient candidates in the first instance unless there is an increase in the size of the available pool. This is the question that will be addressed in this chapter.

A. HISTORICAL RECORD

In aggregate, the officer candidate supply picture appears bright. In FY 1981, the Navy recruited 4860 candidates against a goal of 4817, or 101%. Results such as these sometimes lead officials to paint a glowing picture of the officer supply situation. Testifying before the House Armed Services Personnel Subcommittee on March 8, 1982, the Assistant Defense Secretary Lawrence J. Korb said

> ...there is a surplus of would-be-officers, with 10 qualified applicants for each spot available in the service academies, 6 for each Reserve Officer Training Corps scholarship and 3 for each opening in Officer Candidate Schools. [Monterey Peninsula Herald, Tuesday, March 9, 1982]

However, the aggregated figure conceals a severe shortfall in the nuclear-power programs. In fairness to Mr. Korb, it must be pointed out that he did go on to say that "some personnel shortages continue ... in nuclear trained officers." (Author's emphasis.)

Table 30 shows the break-down of accessions against goals for each officer candidate program. It can be seen that all of the non-nuclear programs except the Civil Engineering Corps (95% of goal) achieved 100% of their goal or better.

TABLE 30

MAJOR OFFICER PROGRAM ATTAINMENT

FY 1981

PROGRAM	GOAL	ATTAINED	PERCENT
Aviation Officer Candidate	890	928	104
Naval Flight Officer Candidate	510	536	105
Surface Warfare Officer	980	1009	103
Supply Officer	419	436	104
General Unrestricted Line (1105)	325	330	102
Physicians	75	106	141
Nurses	198	198	100
Civil Engineer Corps Officer	85	81	95
Nuclear Power Instructor	61	35	57
Nuclear Propulsion Officer Candidate (NUPOC)	284	138	49

SOURCE: Draft Navy Manpower/Personnel Status Report, Unpublished HASC Report, Oct 1981.

The nuclear-power instructor program achieved 57% while the Nuclear Propulsion Officer Candidate program (NUPOC), which primarily involves recruiting engineers, mathematics, and physical science majors in their junior or senior year in college, or upon graduation, for commissioning into the nuclear submarine force achieved only 49% of its goal of 284. This shortfall occurred in spite of the fact that approximately 23% of officer recruiter assets were dedicated solely to the NUPOC program.

It is interesting to note that during FY 1981 only 54% of the surface-warfare nuclear power officer recruiting goal was attained. As a result, the NUPOC program has been expanded to include recruitment of surface-warfare nuclear-power officers. Previously, all NUPOC accessions entered the submarine force unless they became not physically qualified for submarine duty after commissioning and entry into the program. This development is not likely to assist recruitment into the submarine force. On the contrary, it is likely to make it more difficult since candidates who previously were prepared to accept submarine duty now have the option of selecting surface duty. Expansion of the program may well attract candidates who previously would not accept submarine service, but it may also attract to the surface fleet candidates prepared to accept submarine service in the absence of any other option. Another implication of the shortfall in surface-warfare-nuclear-power-officer volunteers is that a policy of lateral entry of

nuclear qualified officers from the surface fleet to the submarine force is simply "robbing Peter to pay Paul" and does not attack the overall shortage of nuclear qualified officers.

B. SOURCES OF SUPPLY

1. Qualifications Required

In general, an officer candidate must be a U.S. citizen, meet specified physical standards, and, except for U.S. Naval Academy entrants who are recruited after graduating from high school, either hold or be in pursuit of a baccalaureaute degree at an accredited institution. Nuclear power candidates must have at least one year of college calculus through differential and integral calculus and one year of calculus-based physics with a "B" average or better. If the degree held, or being pursued, is in a physics, mathematics, or engineering curriculum major, the candidate must have a "C" average or better in all technical science courses including calculus and physics.

2. Avenues of Entry

There are three major officer candidate programs leading to service in the nuclear submarine force. The United States Naval Academy (USNA) intakes high school graduates who then complete their baccalaureate degrees while at the Academy. Academy graduates who meet the educational and physical qualifications described above may volunteer for service in the nuclear submarine force. The other two programs are

the Naval Reserve Officer Training Corps (NROTC) and the NUPOC program already discussed. Both programs recruit on college campuses although graduates may apply for the NUPOC program. Candidates accepted through the NUPOC program attend the Navy Officer Candidate School in Newport, Rhode Island, and are commissioned before going on to Nuclear Power School. Entrants through the USNA and NROTC programs are commissioned on graduation and go directly to Nuclear Power School. Since 1977 total accessions from the three sources have averaged around 66% of goals.

a. U.S. Naval Academy

Since 1974 voluntary accessions from USNA have averaged about 191 per annum while class sizes have averaged around 913 per annum. Since future class sizes at the Academy are expected to be restricted to less than 1000 for various reasons, not the least of which are building restrictions, it has been assumed that accessions from the Academy will continue at about the same level, i.e., approximately 200 per annum, throughout the decade.

b. NROTC/NUPOC

If it is accepted that the number of accesssions from the Academy is going to be fixed through the decade, then clearly any increase in the number of accessions must come through the NROTC and NUPOC programs, both of which recruit out of the pool of college undergraduates, and recent graduates in the case of the NUPOC program. Consequently,

projected changes in the size of this pool are of considerable interest when discussing future accession needs.

(1) <u>The Target Population.</u> It is not enough, however, simply to consider changes in the number of college graduates, because the requirements of the nuclear-submarine force severely limit who may apply. First of all, applicants must be U.S. citizens, and published data on college graduates include a large number of foreign students. Secondly, only males are accepted, and they must be between the ages of 19 and 29 years at the time of commissioning. In addition, the vast majority of acceptances are engineering, mathematics or physical science majors. In 1980, 75% of acceptances from the NROTC program, excluding non-volunteers, were engineers, 22% were math/physical science majors, and only 3% were non-technical majors. In 1981, 70.5% were engineers, 19.7% were math/physical science majors, and 9.8% were non-technical majors. As a consequence the population of interest is reduced in the first instance to male graduates between the ages of 19 and 29 years who are U.S. citizens. To refine the analysis even further, a target population consisting of engineering and math/physical science majors is defined.

Unfortunately, unlike enlisted recruitment, there have been no studies on the propensity "to enlist" of college graduates, and the implicit assumption must be that whatever propensity they have shown in the past will continue into the future. Similarly, no studies are available on the proportion expected to be medically fit, so, once again,

it must be assumed that past proportions will continue into the future. It must also be assumed that the same proportion of graduates will continue to meet the grade-point-average requirements. Finally, although the group of interest is from 19 to 29 years of age, data, such as that published by the National Center for Education Statistics (NCES) and similar sources, are broken into an 18-24 age group.

Taken all at once, these assumptions appear to be overwhelming, but, when considered carefully, it is likely that each of them is quite reasonable and will not significantly bias the analysis. Given the narrow definition of the target population, it is likely that its characteristics will be relatively stable over time. Of some concern is the lack of data on the effect of economic factors, such as the employment rate, on officer candidate enlistment behavior. But, as will be seen, the unemployment rate of the target population is so low that the impact of a change is likely to be only marginal.

C. THE SUPPLY OF COLLEGE GRADUATES

The expected supply of college graduates depends of course on the expected number of enrollments after allowing for a four year lag. Estimating this number is far from simple because enrollment levels are subject to many changing forces, and wide fluctuations in the number of enrollments must be expected. Published projections range from a pessimistic decline of 40 or even 50 percent through "no change" to

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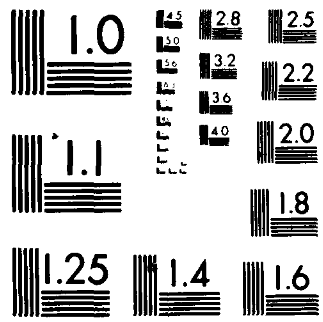

MICROCOPY RESOLUTION TEST CHART

increases of 25 or even 40 percent. The differences occur as a result of different assumptions being made about participation rates, high school graduation rates, attendance by adult and foreign students and economic projections of the private rate of return on investment in higher education.

1. <u>All Graduates</u>

Nevertheless, after more than three centuries of steady increase, there is now the prospect of declining enrollments over the next 20 years as the size of the 18-24 age cohort declines. This traditional college-attending cohort is predicted to decline in number by approximately 23% between 1981 and 1997. In a report published in 1981, the Carnegie Council on Policy Studies in Higher Education predicted a decline within a range of 5% (C in Table 31) to 15% (B in Table 31) in undergraduate full-time enrollments [Ref. 16]. The factors considered in the Carnegie model are also illustrated in Table 31, together with their individual impacts on enrollments. Column (a) shows the impact on all enrollments as assessed by the Carnegie Council. In column (b) the effect of factors that do not impact on 18-24 males, i.e., the target population, have been deleted. With these effects deleted, the decline in the college undergraduate population from which officer candidates may be recruited lies within a range of 18% to 23%. This is considerably greater than the projected decline for all undergraduate enrollments.

Considering the actual number of graduates in the 18-24 age cohort during the 1980's is beyond the scope of

TABLE 31

POTENTIAL DECLINE IN FULL-TIME EQUIVALENT UNDERGRADUATE ENROLLMENT

1978 - 1997

FACTORS CONSIDERED	IMPACT ON TOTAL UNDERGRADUATE ENROLLMENTS		
	ALL (a) UNDERGRADUATES	POTENTIAL (b) OFFICER CANDIDATES	OFFICER
	%	APPLICABLE	%
Decline in 18-24 age cohort	-23.3	YES	-23.3
Adjusted for the 80 percent that this age cohort contitutes of all enrollments	-19	YES	-19
Adjusted for increase in population 25 and over at constant college participation rates (+ 4 percent)	-15	NO	-19
Adjusted for increase in % of population 25 and over with college experience and resultant higher college participation rates (+ 5 percent)	-10 (A)	NO	-19 (A)
Adjusted for potential further decrease in participation rates by males 18-24 (- 5 percent)	-15 (B)	YES	-24 (B)
Adjusted for changes in other components:			
More blacks and more participation by blacks (+ 2 percent)		YES	
More participation by majority women 18-24 (+ 4 percent)		NO	
Increased retention (+ 4 percent)		YES	
Impact of increasing proportion of part-time enrollment (- 5 percent)		YES	
Net: percent (a) +5 (b) +1			
Applied to (A)	-5 (C)		-18 (C)
Applied to (B)	-10 (D)		-23 (D)

SOURCE: Carnegie Commission, 1981

this thesis. However, it seems certain that the number of enrollments is going to decline from around the fall of 1983, and a decline in the number of graduates beginning in the mid-1980's may therefore be expected.

2. Engineering, Mathematics and Physical Science Graduates

When the analysis is restricted to male Engineering and Math/Physical Science graduates (EMP), the water becomes even murkier since additional assumptions must be made. The number of new graduates during the 1980's will no doubt be affected by the decline in the 18-24 age cohort, but assumptions must also be made about the proportion of high school graduates who will enter EMP programs and the ratio of degrees to freshman enrollments. Since the nuclear submarine force does not accept female applicants, only projections on the number of male applicants are relevant in this study. This requires an additional assumption on the proportion of females in each graduating class.

a. Engineering

Table 32 shows both historical and projected numbers of engineering bachelor degrees as forecast by the Scientific Manpower Commission (SMC) [Ref. 17]. The projections are based on junior enrollments for 1982 and freshman enrollments for 1983/84 and a 70% ratio of degrees awarded to freshmen enrollments. The projections for 1985 through 1989 are based on projections made by the NCES after adjusting the 10% of women sex ratio used by the NCES. This ratio was found to overestimate the number of male graduates when

TABLE 32

ENGINEERING BACHELOR DEGPEES, BY SEX

1969-81 AND PROJECTED TO 1998

YEAR	TOTAL	MEN	WOMEN
1969	39,972	39,644	328
1970	42,966	42,608	358
1971	43,167	42,814	353
1972	44,190	43,665	525
1973	43,429	42,805	624
1974	41,407	40,663	744
1975	38,210	37,332	878
1976	37,970	36,594	1,376
1977	40,095	38,134	1,961
1978	46,095	42,815	3,280
1979	52,598	47,873	4,716
1980	58,742	53,062	5,680
1981	62,935	56,390	6,545
	Projected by SMC		
1982*	65,373	57,548	7,825
1983*	69,581	62,068	7,513
1984*	75,999	65,148	10,851
1985+	75,782	64,960	10,822
1986+	74,243	63,690	10,553
1987+	72,566	62,280	10,285
1988+	71,789	61,450	10,339
1989#	71,372	60,970	10,402
1990#	68,060	58,050	10,010
1991#	69,322	59,130	10,192
1992#	70,987	60,570	10,417
1993#	68,820	58,725	10,095
1994#	64,030	54,630	9,400
1995#	61,250	52,200	9,050
1996#	60,645	51,705	8,940
1997#	61,500	52,425	9,075
1998#	61,215	52,200	9,015

TABLE 32 (continued

Notes:

* Based on present enrollments at Junior Year (1982) and Freshman Year (1983 and 1984).

+ Based on NCES intermediate projections of total degrees at 13.3% for men, 2.4% for women.

Based on number of high school graduates 4 years earlier -- 4.5% for men, 0.75% for women.

High school graduates estimated at 71% of males and 76% of females in averaged 17-18 year old population.

Source: National Center for Education Statistics

Source: Engineering Manpower Commission and Scientific Manpower Commission.

compared with actual 1979/80 data. The estimates for 1990 through 1998 are based on the estimated number of high school graduates four years earlier and a value of 4.5% of male and .75% of female graduates entering the engineering curriculum.

The projections indicate a continuing rise in the number of degrees awarded to a peak in 1985, followed by a steady decline through 1998. The number of degrees awarded to males rose by approximately 25% from 1970 to 1980 and is projected to rise a further 18% by 1985. However, by 1990 the total is expected to decline to around 58,000, an increase of only 9% over the 1980 total. By 1998, the total is expected to decline even further to slightly less than the 1980 total.

Although not so pessimistic as might have been expected after the analysis of the previous section, the above projections are based on two critical assumptions. If these assumptions do not hold, then the actual number of degrees awarded may be expected to fall considerably. Firstly, it is assumed that the level of unemployment among engineering graduates, presently less than 1.5%, will remain low, and beginning salaries will remain high relative to salaries offered to baccalaureate graduates in other fields. Secondly, the projections assume that schools of engineering will not be forced to cut back on enrollments because of a shortage of faculty, a shortage that is already being felt in some schools. In the fall of 1981, the faculty shortage, which has been caused by the high demand for baccalaureate-level

graduates, was approximately 2500 [Ref. 17]. If the demand for engineering graduates remains high, fewer graduates will go on to post-graduate work, thus making it difficult to eliminate the faculty shortage. The proportion of engineering graduates entering full-time graduate study has dropped from 20% in 1975 to 12% in 1979 and 1980 [Ref. 17].

b. Mathematics and Statistics

The number of mathematics and statistics degrees has fallen from 27,442 in 1970 to 11,473 in 1980 (Table 33). Complete data are not yet available but this figure is expected to show a further decline to about 8100 for 1981 and remain fairly steady at that figure through the rest of the decade. The number of degrees awarded to males is expected to fall by about 11% during the period 1981 through 1989. However, this fall should be viewed in the context of the rapid decline in degrees during the 1970's. In view of the margin of error implicit in forecasting, the supply of mathematics and statistics graduates can, for practical purposes, be viewed as remaining steady during the 1980's.

c. Other Physical Sciences

A similar analysis may be applied to the physical sciences, i.e., physics and chemistry, where the number of baccalaureate degrees awarded has remained relatively constant through the 1970's (Table 34). After a peak in 1969, the number of physics degrees awarded declined steadily, albeit slowly, through the 1970's. However, this decline in supply

TABLE 33

MATH/STATISTICS BACHELOR'S DEGREES
1970 - 1980 AND PROJECTED TO 1989

YEAR	TOTAL	MEN	WOMEN
1970	27,442	17,179	10,263
1971	24,801	15,376	9,425
1972	23,713	14,464	9,249
1973	23,067	13,794	9,273
1974	21,635	12,786	8,849
1975	18,181	10,581	7,600
1976	15,984	9,478	6,506
1977	14,196	8,304	5,892
1978	12,569	7,365	5,204
1979	12,115	7,075	5,040
1980	11,473	6,620	4,853
	PROJECTED		
1981	8,120	5,000	3,120
1982	7,940	4,860	3,080
1983	7,960	4,840	3,120
1984	7,940	4,780	3,160
1985	7,900	4,710	3,190
1986	8,020	4,630	3,390
1987	8,000	4,540	3,460
1988	8,100	4,480	3,620
1989	8,180	4,440	3,740

SOURCE: National Center for Education Statistics

TABLE 34

PHYSICS AND CHEMISTRY BACHELOR DEGREES

1971 - 1980

YEAR	PHYSICS	CHEMISTRY
1971	5,755	11,183
1972	5,282	10,721
1973	4,923	10,222
1974	4,652	10,517
1975	4,571	10,649
1976	4,487	11,107
1977	4,517	11,215
1978	4,457	11,474
1979	4,416	11,643
1980	4,440	11,446

Source: National Center for Education Statistics, American Institute of Physic's

appears to be ending as job opportunities get closer in balance with the number of new graduates [Ref. 17]. Similarly, since 1970, the number of chemistry degrees awarded has remained fairly stable around 11,000 per annum, except for a drop in 1972 and 1973. No data are available on the sex ratio of graduates, but in 1980 women made up 13% of physics and 25% of chemistry bachelor graduates.

D. THE DEMAND FOR COLLEGE GRADUATES

The demand for college graduates either collectively or by particular disciplines is difficult to assess since demand can be defined in many ways. At what level of unemployment may demand and supply be considered to be in balance? How is the level of unemployment measured? Is a graduate working outside his or her field unemployed? These questions and other data problems make an accurate assessment of the future demand for graduates very difficult indeed, particularly if the time horizon examined is greater than just a year or two. However, demand is the other side of the supply coin and must be addressed to give meaning to predicted changes in supply. On its own a projected change in the supply of graduates tells little about the future recruiting environment. To make some prognosis about that requires some feel for the demand side of the equation.

1. All Graduates

Historically, the demand for college graduates has risen along with the increase in supply. The Carnegie

Commission attributes this primarily to the increasing proportion of the labor force engaged in professional and managerial occupations and predicts that after an uncharacteristic slump in the 1970's, a period during which the Navy still failed to recruit sufficient numbers of nuclear propulsion officer candidates, this long run upward trend will continue. The Commission feels that the combination of a declining supply and a continuing firm demand will produce improving job prospects for graduates during the 1980's unless the rate of economic growth falls to abnormally low levels, say less than 2% per annum.

This prognosis is supported by two long-term ongoing surveys that measure the demand for new graduates, the College Placement Council (CPC), which reports three times per year, and an annual report by Frank S. Endicott of Northwestern University. For 1982 the CPC survey predicts a 15% increase in job opportunities for new graduates while Endicott predicts an 11% increase [Ref. 18: p. 73].

The SMC does not appear to be so optimistic, however, and expects that about 3 million of the approximately 13.5 million graduates entering the labor force between 1978 and 1990 will have to seek employment in a non-traditional occupation, or face unemployment. Unfortunately, this does not directly translate into a greater supply of potential officer candidates. In the past, unemployed graduates have been able to find employment by accepting positions in occupations not

normally filled by graduates, such as clerical and blue collar occupations and in service industries. The question is whether a graduate prefers to accept civilian employment outside his field over joining the Navy, where he may be able to utilize his training more directly, i.e., how anxious he is to use his newly acquired skills.

2. Engineering, Mathematics, and Physical Science Graduates

Although there is some disagreement on the projected demand for all graduates, there is general agreement that graduates in the technical disciplines are in a much better position. Table 35 shows the percentage increase in new hires from 1978 to 1979 by employers recruiting from College Placement Offices for graduates with particular types of training. As can be seen, the increase was greatest in the technical disciplines, the traditional source of nuclear propulsion officer candidates, indicating strong civilian competition for this type of graduate.

Furthermore, this competition is expected to continue. A U.S. News and World Report survey predicts that for 1982 demand will increase by 21%, and starting salaries, already higher than the military offers [Ref. 19: p. 29], will be "up some" on 1981 [Ref. 18: p. 73]. Starting-salary data show that engineers continue to top all bachelor degree graduates in terms of beginning salary levels. The October 1981 CPC survey predicts an increase for 1982 of 12% in

TABLE 35

PERCENTAGE INCREASES IN HIRES BY CURRICULAR GROUPINGS AND DEGREE LEVELS, BY RECRUITING THROUGH COLLEGE PLACEMENT OFFICES, JUNE 1978 TO JUNE 1979

Curricular Groupings	Bachelor's Level	Master's Level	Doctoral Level	All Levels
Engineering (including engineering technologies)	22%	24%	31%	22%
Sciences, math, and technical (including computer science, etc.)	20	17	20	19
Business (including accounting, marketing, business management, etc.)	11	16	(a)	12
Nontechnical (including liberal arts, social science, home economics, etc.)	4	17	3	5
Total, excluding federal government	14	18	22	15
Total, including federal government	9	18	22	10

(a) Number of cases very small

SOURCE: Carnegie Commission, 1981

engineering[1] hires and 23% in the science, mathematics, and other technical disciplines[2] at the bachelor's level. Another study, by the Bureau of Labor Statistics in August 1981, predicts a higher-than-average rate of growth of total employment in the technical areas [Ref. 17].

In 1980 less than 1% of nuclear or ocean engineering graduates were seeking work and had no offers. The Bureau of Labor Statistics reported an overall unemployment rate for engineers of only 1.3% for 1980 and 1.5%, 1.4% and 1.3% respectively, for the first 3 quarters of 1981 [Ref. 17]. Not many of the 3 million graduates accepting work outside their field will be engineers, and even fewer may wish to join the nuclear Navy to be able to work in their area of specialization. No doubt, many will view civilian employment even outside their field, as more desirable than Naval service. An indication of the increasing level of civilian competition can be seen in the experience of the United States Air Force. In 1968, the Air Force recruited over 5% of the college engineering graduates. Currently they are able to recruit only about 1.5%, which is well short of their goal [Ref. 19: p. 29].

E. CONCLUSION

Although the decline in the size of the 18-24 age cohort is known with some certainty, it is by no means certain that

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[1] Includes engineering technologies.

[2] Includes computer science, geology, etc.

they will have the same college participation rates as previous generations, or that their academic performances will be the same. Data on graduate school applicants supplied to the Carnegie Council by the Educational Testing Service indicate that the academic performances of graduates as measured by scores on tests taken before entering graduate work has deteriorated significantly [Ref. 16].

This deterioration could indicate that not only is the size of the graduate pool declining but also there could well be a decline in the proportion of that pool who reach the academic standards required for entry into the nuclear submarine force.

There are some contradictions in the demand vs supply projections for all graduates, but the situation with engineering graduates is even less clear. The supply of new graduates has been increasing since 1975 and is expected to continue to do so at least until 1985, but the level of demand is also rising, albeit less predictably. If demand continues to rise past 1985, then severe shortages are certain unless something is done to arrest the predicted drop in supply after that year. The effect of proposed increases in defense expenditures on the demand for engineers in the civilian labor market is still not clear, and there is some disagreement as to whether the supply will exceed demand or whether shortages will exist in the later part of the 1980's. Because of the nature of most defense contracts, changes in government

policy in this area have a significant impact on the demand for engineers and other technically trained personnel.

Nevertheless, it seems clear that the market for technically qualified graduates in general and engineers in particular is going to remain very tight during the 1980's. During Congressional testimony on July 21, 1981, the Under-Secretary of Defense for Research and Engineering, Richard D. De Lauer, reported a projected shortage of industrial engineers of 49% over the next 10 years [Ref. 20: p. 27]. In a separate study, the Bureau of Labor Statistics put a figure on this projection when they projected a net nationwide shortfall of 16,000 engineers each year for the period 1980-1990 [Ref. 19: p. 26]. Today, engineers and other technically qualified graduates have considerably less trouble finding employment in this field than do graduates in non-technical disciplines, and the weight of evidence suggests that this situation will continue through the decade of the 1980's.

Great uncertainties also exist about the impact of many other factors, such as changing economic conditions or government policies, that can have a profound impact on enrollment levels. Any rigorous study of future officer supply should explicitly take these factors into consideration. To some extent the military, by expanding simultaneously in almost every area, is competing against itself. Increased efforts to recruit more Category I and II high school graduates into the enlisted ranks, if successful, may well reduce the pool

of college graduates with a positive propensity towards military service. In addition, all of the Services are trying to attract a greater number of technically trained officer candidates, and, since there is only one common supply pool, they are in direct competition with each other.

When it is recalled that the nuclear submarine force has consistently failed to meet its officer accession goals during a period (1960-1980) when the number of both EMP and non-technical graduates was increasing, there can be little doubt that, in the face of an increased requirement for accessions, a declining supply pool and increased competition, recruiting sufficient numbers of quality officer candidates will be a major challenge during the 1980's.

VII. SUMMARY AND CONCLUSION

Forecasting is, at best, a risky business. There are too many unknown and unknowable factors at work for any manpower planner to project into the future with certainty. The problems are magnified when the accuracy of the historical data on which the projections are based can also be called into question. How can one be sure what attrition rates will be in the future if one does not even know with certainty what they have been in the recent past? Even if one does know precisely, this is no guarantee that historical rates will continue into the future. Nevertheless, the analysis of this thesis leaves room for some optimism. Shortages are projected but they are not overwhelming. Realistic policies are suggested that eliminate all projected shortages within a reasonable time frame. As was emphasized on several occasions, no attempt was made to project "the" future manpower position of the nuclear submarine force or to present "the" solution. Rather, the intention was to place some parameters around the problem of manning the nuclear submarine force of the 1980's and beyond; hence, the use of four levels of demand, and low, medium and high attrition vectors. At each step a range of alternatives was presented and the reader left free to follow that path which he considered the most realistic.

A. SUMMARY

Chapter I provides a brief introduction to the nature of the officer manpower problem faced by the nuclear submarine force and the purpose, methodology and necessary assumptions of the study. In Chapter II, four levels of demand are presented. Each level was based on different assumptions on which positions must be filled by nuclear qualified officers, and on different sea/shore rotation ratios. In Chapter III, six possible supply projections are presented on the basis of three different attrition vectors and two promotion rates. Each possible supply scenario was compared with each demand scenario in Chapter IV. Projections out to 1990 only are examined in an effort to identify the immediate manpower problems of the submarine force. An important finding of this chapter was that, although significant shortages are projected for CDR's and LCDR's under all but the most optimistic projections, no shortages are projected for LT's and LTJG's regardless of the level of demand or attrition vector. In the short term, i.e., 1982-1990, increasing the number of accessions will not affect the shortage of senior officers and increased accessions into the junior ranks are not required.

In Chapter V, the problem of manning the submarine force in the long term was addressed. To simplify the analysis only demand level B (high manning/high ratio) and supply projection II (medium attrition) were considered. <u>All</u> projected shortages can be eliminated by 1995 simply by increasing the accession

rate. Even if the accession rate is not increased above its present level of approximately 400 per annum, the only shortage that persists in steady state is some 112 LCDR's. However, even at the highest projected accession rate, short term shortages occur during the 1980's and early 1990's in the rank of LCDR and for CDR during the period 1986 to 1991. If a lateral entry program is introduced, the shortage of LCDR's can be eliminated. If the accession rate remains at its current level such a lateral entry program will need to be ongoing, but if the accession rate can be increased even to the medium rate, then lateral entry will be required only until about 1987. No lateral entry program short of entry at CDR level, or very senior LCDR, can reduce the projected shortage of CDR's in the period 1986 to 1988.

Finally, in Chapter VI, the projected supply of college graduates, particularly engineering, mathematics and physical science majors was examined in an attempt to assess the future recruiting environment for potential officer candidates qualified to enter the nuclear submarine force. Although the data are subject to interpretation, it seems clear that the market for the type of graduate sought by the nuclear submarine force is going to remain tight during the 1980's. Increasing the number of accessions is a viable long term solution to the officer manpower shortages projected, but to increase accessions, even by 100 per annum, will not be an easy task. If a policy of increased accessions is implemented, it will have

to be accompanied by an aggressive recruiting program that can compete effectively against some fierce competition in the civilian labor market.

B. CONCLUSION

This study has identified three decision areas in which policies may be implemented to attack officer shortages:

1. attrition rates
2. accession rates
3. lateral entry.

The optimistic projections under the low attrition vector demonstrate vividly the benefit to be gained by reducing attrition rates. But this point is generally well appreciated and does not need belaboring. The decision here is not whether to reduce attrition rates but how, and by how much?

The remaining decision areas should, however, be evaluated in the context of the particular pattern of shortages projected. Because shortages are projected at the CDR and LCDR level, but not in the junior officer ranks (LT and LTJG), increasing the number of accessions is not the answer to the officer shortages faced by the nuclear submarine force during the 1980's. In the long term, past 1993, a policy of increased accessions can eliminate all of the projected shortages. In fact, in the long term, increasing the number of accessions or reducing attrition rates are policy alternatives.

Determining the most cost effective mix of policies designed to reduce attrition and policies designed to increase the number of accessions is already the subject of study by the Center for Naval Analysis, at least at the enlisted level. However, short of a significant reduction in attrition rates among CDR's and LCDR's, the nuclear submarine force has no alternative but to accept a policy of lateral entry if it is desired to fully man the force with nuclear qualified officers during the 1980's and early 1990's. When considering such a policy the term "lateral entry" is not defined simply as reduced attrition, but any entry into the nuclear submarine force, from whatever source, at any level other than Ensign. In this case, entry at LCDR level is proposed and multiple sources of supply should be considered. Once the initial shortfall has been overcome the annual requirement for lateral entrants is not large. Recruiting efforts could be very specific, even down to approaching individuals e.g., prior service officers or civilians employed in the nuclear power industry. The continuing controversy over the development of nuclear power plants has reduced employment in the civilian nuclear power field and an aggressive lateral entry recruiting campaign directed at experienced nuclear power engineers may well be quite successful.

Manpower planners in the nuclear submarine force have three policy options to consider: reducing attrition, increasing accessions, and introduction of a lateral entry

program. The most cost effective mix of these three policies is a subject for further research, but the final mix will be determined largely by the unique pattern of shortages and surpluses projected between today and the end of this century.

APPENDIX A

TRANSITIONAL DATA

NUCLEAR QUALIFIED SUBMARINE OFFICERS

COLUMN	YCS	RANK	PROMOTION RATE "PLAN"	PROMOTION RATE "REVISED"	ATTRITION RATE "HIGH"	ATTRITION RATE "MED"	ATTRITION RATE "LOW"
1	3	LTJG	--	--	.0385	.0821	.001
2	4		*	*	.1344	.1536	.060
3	5	LT	--	--	.3286	.3473	.247
4	6		--	--	.1930	.2500	.165
5	7		--	--	.2714	.1707	.130
6	8		.0388	.1	.0862	.0740	.069
7	9		.8276	.95	.0964	.0486	.068
8	10		.5417	.75	.4583	.0803	.047
9	11		--	--	1.0	1.0	1.0
10	9	LCDR	--	--	0	.0486	.068
11	10		--	--	.0610	.0803	.047
12	11		--	--	.1034	.060	.044
13	12		--	--	.1636	.060	.032
14	13		--	--	.1325	.060	.022
15	14		.0246	.0246	.1154	.060	.011
16	15		.7792	.7792	.1620	.050	.003
17	16		.2222	.2222	.6349	.050	.003
18	17		--	--	0	.050	.003
19	18		--	--	0	.050	0

COLUMN	YCS	RANK	PROMOTION RATE "PLAN"	"REVISED"	ATTRITION RATE "HIGH"	"MED"	"LOW"
20	19	LCDR	--	--	0	.050	0
21	20		--	--	.329	.40	.027
22	21		--	--	.666	.60	.057
23	22		--	--	1.0	1.0	1.0
24	15	CDR	--	--	0	.050	.003
25	16		--	--	.0370	.050	.003
26	17		--	--	.0652	.050	.003
27	18		--	--	.1356	.050	0
28	19		--	--	.1754	.050	0
29	20		#	#	.9074	.087	.064
30	21		#	#	.3077	.6614	.6724
31	22		--	--	.8293	.0744	.0584
32	23		--	--	.50	.50	.070
33	24		--	--	1.0	1.0	1.0

* 100% of LTJG who do not attrite are promoted. The promotion rate therefore varies with the rate of attrition and is equal to 1 minus the rate of attrition.

\# Promotion to captain is included in the rate of attrition since these officers are leaving the "system" as defined.

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